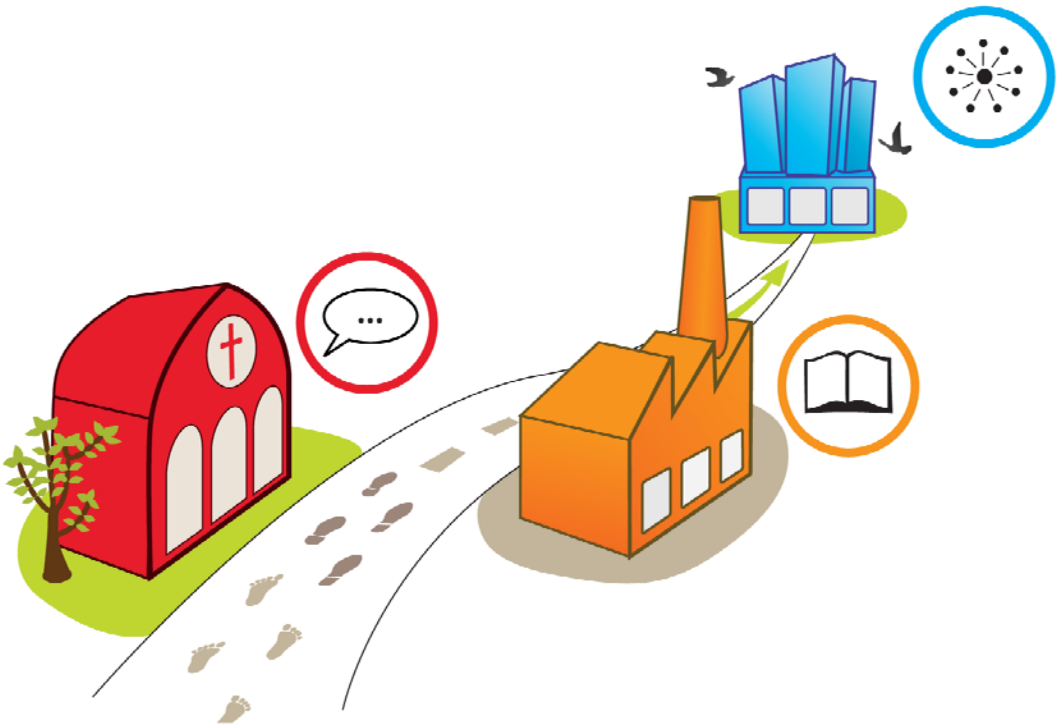
The Facilitating University

Positioning Next Generation Educational Technology



1st generation university
Scholasticism
education oriented
Latin as lingua franca
high mobility
oral dissemination
ruled by religion

2nd generation university
Enlightenment
research oriented
mother tongue
low mobility
journal dissemination
ruled by government

3th generation university
Sustainability
valorisation oriented
English as lingua franca
virtual mobility
open access dissemination
ruled by market

Piet van der Zanden

The Facilitating University

Positioning Next Generation Educational Technology

Colofon

A.H.W. van der Zanden
a.h.w.vanderzanden@tudelft.nl

Delft University of Technology
Shared Service Centre - ICT
Systems for Education, Research and Organisation
Landbergstraat 15
2628 CE Delft

Delft University of Technology
Faculty of Technology, Policy and Management
Education & Technology
Jaffalaan 5
2628 BX Delft

ISBN 978-90-5972-352-8

Published and distributed by:
Uitgeverij Eburon
Postbus 2867
2601 CW Delft
Tel: 015 – 213 14 84
Fax: 015 – 214 68 88
info@eburon.nl
www.eburon.nl

Keywords: facilitating university, ict in education, higher education, educational technology, educational practice, growth, uses, s-curve, progress, types of knowledge, valorisation, stages model, nector

Comic design by A. (Ayla) Maagdenberg, Delft, 2009
Lyrics and storyboard by A.H.W. (Piet) van der Zanden, Delft, 2009
Cover design by C. (Charlotte) Kobus, Den Haag, 2009
Lay-out by A.H.W. (Piet) van der Zanden, Delft, 2009

THE FACILITATING UNIVERSITY

POSITIONING NEXT GENERATION EDUCATIONAL TECHNOLOGY

DE FACILITERENDE UNIVERSITEIT

POSITIONERING VAN TOEKOMSTIGE ONDERWIJSTECHNOLOGIE

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof. dr. ir. J.T. Fokkema,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen

op donderdag 10 december 2009 om 10:00 uur
door

Adrianus Hendrikus Wilhelmus VAN DER ZANDEN

Hogere Opleiding Elektronikatechniek PBNA te Arnhem

geboren op 24 juni 1959
te Delft

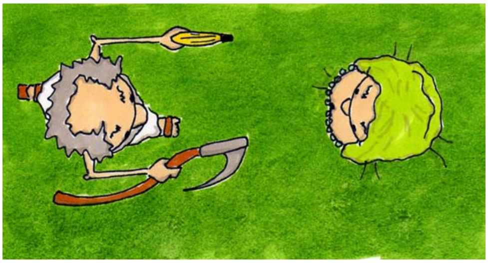
Dit proefschrift is goedgekeurd door de promotor:
Prof. dr. W. Veen

Samenstelling promotiecommissie:

Rector Magnificus	Delft University of Technology, voorzitter
Prof. dr. W. Veen	Delft University of Technology, promotor
Prof. Dr. R. Carneiro	Universidade Católica Portuguesa, Portugal
Prof. Dr.-Ing. K. Henning	RWTH Aachen, Germany
Prof. Dr. A. Krokan	University of Trondheim, Norway
Prof. Dr. A.E. McFarlane	University of Bristol, United Kingdom
Prof. dr. P.R.J. Simons	Utrecht University, The Netherlands
Prof. dr. ir. A. Verbraeck	Delft University of Technology, The Netherlands

- *Confidential data provided by Blackboard and used with permission*
- *Sponsored by Shared Service Centre - ICT, Delft University of Technology*

The Banana Dialogue



Another day, sitting in his heavenly penthouse, Father Time took a banana, and on going to peel it, looking down on it, he saw it was straight. "Why is my banana so straight?", he thought, "It is just as straight as my wanderings".

Father Time always walks in a straight line through time, ever moving forward, though sometimes looking back whilst still moving forward. He just follows his big nose and his sandled feet, scythe in hand and hour glass in bag.

Banana in his hand he jumped down from heaven to take a walk. On his way he met Mother Nature.
"Nice curved banana", she said, "Your beautiful banana has the same natural curves as my fruitful body", she smiled.

Father Time raised his eyebrow, he stumbled. "But my dear, you have such attractive curves and my banana is straight, as straight as my timeline."

Mother Nature grinned and responded: "Oh, you fool, approach your banana from another perspective."

In a sudden deep voice she said; "Take a right turn, right now. Only then you will discover your banana's beauty. So, please, do so, now!"

"Hah, Father Time, you have always looked down on me, but now that you have finally made a turn in your path, you will see the world from another perspective, that of the ordinary man."

"Believe me", she said in a lovely voice,
"In this paradigm your straight timeline has as many fast moments as it has slow. And, …"
Mother Nature whispered, her luscious red lips close to Father Time's ears. "When you take your time to enjoy your banana, you will probably view it with much more curiosity and admire it for its form".

"Then when you are ready you must follow the roads of higher education to discover how changeable and informative such travels are", she said this as if Father Time no longer had time. "I will", he said.
"Yes", she said.

And Father Time walked on … to Chapter 3.

Reading Advise

If you have only 30 minutes of reading time
We advise you to focus on the dissertation outcomes. Start with the problem statement on page 3 and jump to pages 11 to 13 for the research questions, read only the red boxes. Afterwards, read Section 3.8, pages 83 to 89 to find the answer to research sub question A. Jump to Section 5.5, pages 170 to 172 to find the answer to research sub question B. Research sub question C is answered in Section 7.4, pages 191 and 192, while this study is concluded in Section 8.10 at pages 217 and 218.

Are you interested in the methodology, do you have 8 hours of reading time?
We advise you to read the summary first, at pages 227 to 234, followed by Chapters 1 and 2 covering the description of the study, the literature search and theoretical framework. Please also read Section 3.8, pages 83 to 89 to answer research sub question A. Continue with Chapters 4 and 5 covering the case study, data collection and data analysis. The answer to research sub question B is given in Chapter 5. Continue with Chapter 6 where the literature and evidence are confronted, read on in Chapter 7 up to Section 7.4 to follow the reasoning behind the answer to research sub question C, end with Section 8.10, pages 217 and 218 to conclude this study.

Are you more interested in the collected information and do you have 8 hours of reading time?
We advise you to read the summary first, at pages 227 to 234. Afterwards jump to Chapter 3 continuing the results of literature study and the answer to research sub question A. Jump to page 170 to read the answer to research sub question B. Then read Chapter 6 to understand the conclusions derived from confronting literature with the empirical evidence, continue with Chapters 7 and 8 to get a picture of what is coming to higher education.

If you would like to read our hard work, it will take about 30 hours of reading time
We are most honoured and thank you for efforts to wrestle your way through the entire dissertation. Although you may have to persist now and then, we believe you will enjoy the journey we have followed, and that you will be enlightened, and have an idea as to where higher education is wandering and how it will create its position in the coming decades.

LEESADVIES

Als u maar een half uurtje heeft
Lees alleen de onderzoeksuitkomsten. Begin wel met de probleemdefinitie op bladzijde 3 en de onderzoeksvragen op bladzijden 11 tot 13. Bekijk alleen de roodomlijnde boxen. Lees daarna paragraaf 3.8, bladzijden 83 tot 89, met het antwoord op onderzoeksvraag A. Blader daarna naar paragraaf 5.5 op bladzijden 170 tot 172 om het antwoord op onderzoeksvraag B te vinden. In paragraaf 7.4 vindt u het antwoord van onderzoeksvraag C op bladzijden 191 en 192. In paragraaf 8.10 tenslotte, bladzijden 217 en 218, vindt u de eindconclusie.

Bent u geïnteresseerd in de onderzoeksmethodologie en heeft u ongeveer 8 uur aan leestijd?
Lees eerst de samenvatting op bladzijden 235 tot en met 243. Lees daarna de hoofstukken 1 en 2 voor de beschrijving van de studie, het literatuuronderzoek en het theoretisch kader. Lees dan paragraaf 3.8, bladzijden 83 tot 89, voor het antwoord op onderzoeksvraag A. Vervolg met de Hoofdstukken 4 en 5 over de case studie, data collectie en data analyse. Hoofdstuk 5 bevat het antwoord op onderzoeksvraag B. Ga verder met hoofdstuk 6 waar literatuur en proefondervindelijke uitkomsten worden geconfronteerd. Lees hoofdstuk 7 tot en met paragraaf 7.4, waar onderzoeksvraag C wordt beantwoord. Eindig met paragraaf 8.10, bladzijden 217 en 218, voor de eindconclusie.

Bent u meer geïnteresseerd in de onderzoeksuitkomsten en heeft u 8 uur aan leestijd?
Lees eerst de samenvatting op bladzijden 235 tot en met 243. Lees daarna hoofstuk 3, die de uitgebreide literatuurstudie behandelt en ook onderzoeksvraag A beantwoordt. Ga dan naar bladzijde 170 om het antwoord op onderzoeksvraag B door te nemen. Blader naar hoofdstuk 6 om conclusies door te nemen die voortkomen uit de confrontatie van literatuur en empirische uitkomsten. Vervolg met hoofdstukken 7 en 8 om een beeld te krijgen van het toekomstige hoger onderwijs.

Als u het gehele werk wilt doornemen dan neemt dat ongeveer 30 uur aan leestijd
Wij zijn natuurlijk zeer vereerd dat u de moeite wilt nemen om het gehele proefschrift door te worstelen. Alhoewel u zo af en toe flink moet doorzetten, denken we dat de zware tocht zeer de moeite waard is. We denken dat u aan het einde van het proefschrift een helder idée heeft van wat er allemaal op het hoger onderwijs afkomt, en ook hoe de toekomstige universiteit zich op een gedegen wijze kan voorbereiden.

Zo weinig tijd, zo veel te doen …

Was er maar een winkeltje waar ze tijd verkopen
In zakken of dozen, in flarden of pozen
In minuten of uren, dat dagen langer duren
Dan kan ik meer doen, mag ik hopen

Maar ik heb het nog niet gevonden
Ik ben zo moe, aan vakantie toe
Ik wil meer slapen, en minder gapen
Meer tijd beschikbaar, als we dat eens konden

Was er maar een winkeltje waar ze tijd verkopen
Fit aan de dag beginnen, nog meer zou ik je beminnen
Immer zou ik je behagen, altijd je aandacht vragen
Gewoon lekker genieten, zou het eens zo lopen

To my dear wife Petri whose love and support are of infinite value …

CONTENTS

FIGURES

TABLES

SCRIPTS

Glossary

Abductive reasoning	follows the path from effect to cause, for abduction one has to be creative, and inherently, one can find multiple possible causes for a certain effect, for example: No one is online at night where the generic rule might be that the office hours are during the day. The conclusion might be that the VLE is shut down outside office hours, or no one feels obliged to work outside office hours, or there are no night shifts for staff, or the infrastructure provider blocks all communication at night, et cetera.
Adaptive Structuration Theory	is an approach for studying the role of advanced information technologies in organisation change. The change process is examined from two perspectives: 1) the types of structures provided by advanced technologies, called '*appropriation*' and 2) the structures that emerge through human action as people interact with these technologies, called '*structuration*'.
Alma mater	is the school, college or university where one has studied.
ASR	stands for Advance System Reporting, which is a permanent database holding extracts of accumulated and associated data from the Blackboard VLE.
Behaviourism	is based on the change of reflexive behaviour of a person or animal with the help of external stimuli. Behaviouristic experiments are divided into two forms of conditioning: 1) classical conditioning with unconditioned stimuli and 2) operant conditioning with deliberate rewards or punishments.
Bench	is a cooperation of accompanying chairs to valorise authentic ill-structured education projects.
Bloom's Taxonomy	is a classification for six cumulative levels of intellectual behaviour important for learning. The six levels are 1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5) Synthesis and 6) Evaluation.
Bologna Agreement	see Declaration of Bologna.
Bonding	is the process by which a close emotional relationship is developed
Brand	is a particular design or symbol used to advertise an institution's products and services.

Client system	is a computer or other ICT device connected to an institution's system server from which it obtains information.
Cognitivism	is based on exploring the mind while observing the change of outside behaviour. Cognitivists refer to mental processes while external stimuli trigger the learners' behaviour. The change in action is observed and measured by what the learner knows and not by what the learner does. The observation is fed back to the learner, so that he or she knows about the progression.
CBT	stands for Computer Based Training aiming at applications, mainly developed with 'drill and practice' in mind. With doing repetitive exercises a student or worker would learn how to react quickly and appropriately. CBT represents the period of single-user tools. The computer, set to work for office applications such as text editing and spreadsheet calculation, made its entrance within education and was brought into use for mathematics, computer-aided design, simulation programs, infinite calculation methods, producing test result sheets, and the like.
Connectivism	is based on ICT as intrinsic learning principles. Know-how and know-what is being supplemented with know-where as the understanding of where to find the knowledge needed. It adresses learning outside the person, knowledge stored in databases or other electronic information holders accessible through the Internet. Synthesising and recognising patterns, meaning making and forming connections between specialised communities are important activities in the Information Age.
Constructivism	is based on the premises that a learner actively constructs his own understanding through reflection on individual experiences. Knowledge is not transferred from one individual to another but the learner orchestrates, selects and transforms information, constructs hypotheses, and makes decisions to construct knowledge in his or her own way with his or her own rules and his or her own mental models.
Curve Fitting	is the process of constructing a curve, or mathematical function, that has the best fit to a series of data points.
Declaration of Bologna	is held in 1999. It agreed on 1) bachelor and master degrees, 2) mobility through european credit transfer system (ECTS), 3) accreditation for a standard of quality and 4) quality assurance for improving quality of teaching and research.
Deductive Reasoning	is based on reasoning from fact to conclusion, or from cause to effect, where generic rules guide the reasoning, for example: Students work online with the VLE, the generic rule is that everyone communicates, and the consequence might be that the students communicate online.
Diffusion	is the process by which an innovation is disseminated through certain channels over time among the members of a social system. Rogers' five succussive adopter categories are: 1) innovators, 2) early adopters, 3) early majority, 4) late majority and 5) laggards.
EDP	stands for Electronic Data Processing and refers to the use of automated methods to process commercial data, such as large volumes of similar information.
EQF	stands for European Qualifications Framework, which is a translation grid for qualifications around Europe with the purpose to promote student mobility between countries and to facilitate lifelong learning. The EQF consists of eight consecutive levels of corresponding knowledge, skills and competences.
Futures Wheel	is a simple method for identifying and packaging primary, secondary and sometimes tertiary consequences of trends and events within concentric circles.
Enlightenment	is the 18th century period in Western Europe, when many people began to emphasize the importance of science and reason, rather than religion and tradition.
Falsification	argues that one cannot find the truth by verifying or reasoning, but by deleting or falsificating the things that are wrong or do not support an assumption. The assumption that remains will consequently become steadier and may grow into a theory at the end (Popper).
Grid Infrastructures	are large scale distributed computer networks used to share computer power for calculation and storage purposes. A typical feature of grid-infrastructures is the geographical spread of logical components over a network.
Human Excellences	come through human experiences. Four dimensions are 1) intellectual dimension which leads to truth, 2) aesthetical dimension which leads to beauty, 3) ethical or moral dimension which leads to goodness and 4) spiritual dimension which leads

	to unity.
Implementation	is the act to put a plan or system into operation.
Implementation Grade	is the representation of growth for VLE systems. It is the extent of growth from Communities and Courses compared to their maxima within higher education institutes.
Inductive reasoning	is looking for generic rules or patterns based on empirical observations, for example: Two nights ago no worker was online in the VLE, the night before yesterday no one was online, and last night also no one was online. The generic rule might be that no one works at night.
Institutionalisation	is formalising a once informal event into a business critical process to become an important part of the organisation.
Key Principle	is an important idea which has great influence when making a decision or considering a matter.
Know-across	is the competence to see the whole of things, it is multidisciplinary, how multiple parts interrelate to each other, it assesses consequences when processes are triggered or changed. Know-across stands for wisdom and for overseeing the whole of things, not limited to interdisciplinary communication, but overall project outcomes in adjustment with political, economic, ethical, aesthetical and humanist surroundings.
Know-between	is intellect, scientific reasoning, logical derivation separated from the senses, it is elaboration on earlier obtained knowledge, thinking about cause – effect relationships. Know-between is an important communication skill for interdisciplinary collaboration, where methodologies, dimensions, ontologies and techniques must fit.
Know-how	is craftsmanship or workmanship, it is technical insight, skill, craft or art to know how things work and how to reproduce them, things such as systems, models, methods, and techniques dependent of the profession. Know-how is making action in producing an object.
Know-that	is epistemological cognitive knowledge which is based on valid scientific information, it is permanent and unchangeable for the time being, it is knowledge which is taught at school and passed over to the next generation. Valid information is rough data and must be understood within its context. Know-that is an active process of knowing although the facts, figures, and formulas on itself give no meaning.
Know-where	is the understanding of where to find the knowledge needed, to recognise and assess its validity, to synthesise loose parts and to deal with its copyrights.
Know-why	is practical insight and ability for moral thought, it is the mastery to apply something, to know and feel when something will lead to good and not to bad. Know-why is a practical thing, it is a doing action and a result of considerations.
Kondratieff Cycle	is a long-term order, about half a century, of economic behaviour for the purpose of anticipating future economic developments.
LM	stands for Learning Mall, just-in-time, just-enough and just-for-you learning. The Learning Mall consists of distributed electronic virtual knowledge centres equipped with personalised-learning delivery robots based on semantics and grid infrastructures. Every student, undergraduate, graduate, post-graduate, and any other expert, professional or life-long-learner will be able to access its free learning materials.
LoD	stands for Learning on Demand, for online connection, communication and work. It represents the social software oriented learning environments with learning materials distributed online to meet the needs of steadily increasing numbers of multi-disciplinary educational tracks. The underlying systems will be compound systems of merged portal and repository technologies.
Lifespan	is the length of time that a person, animal or thing exists.
Linear Regression	analyses the relationship between two variables and finds the best straight line through the data.
lingua franca	is the language which is used for communication between groups of people who speak different languages, but not used between members of a same group.
Literacy	is defined as knowledge of a particular subject or particular type of knowledge, an educational practice needs some necessary skills to operate and exploit it.
Logging Data	are the recorded sequential data, often chronologically, from the Blackboard VLE.

Nector	is an interdisciplinary professor, a binder scientifically specialised in communication and interaction between multi-disciplines, in adjusting design methodologies, vocabularies, ontologies, dimensioning, techniques, and other interdependencies. Nectors are theorists for process-oriented linking of multi-disciplines, they are practitioners of valorisation projects and coaches for participating students, they publish about approaches, technologies and outcomes, and valorise educational knowledge into products and services. Nector comes from the Latin word 'nectere', which means to bind, to bond, to link.
Nexus	is an important connection between the parts of a system or a group of things.
Network Organisation	is cooperation with a minimum of formal structures, it relies on the formation and dissolution of teams to meet specific objectives. A network organisation utilises information and communication technologies extensively, and it makes use of knoledge across and within companies along value chains.
Nonlinear Regression	Nonlinear regression is a method of finding a nonlinear model that consists of a set of independent variables and one dependent variable.
OLC	stands for Online Learning Course, an actively used Blackboard course.
OL	stands for Online Learning, the time- and place-independent way of learning. It is the period of virtual learning environments (VLE), their multi-user tools, communication tools, the world wide web and online courses. Lecture notes are digitised and put online, as are video lectures together with references to publications via hyperlinks.
Ontology	is a formal, explicit specification of a shared conceptualisation. It provides a shared vocabulary used to model a domain.
Open Services	are supporting services offered on the market that compete with institutionalised systems. Technical and application maintenance of for instance email, portals, repositories, logistics and other systems may be outsourced in such way.
Paradigm	is a framework of series of converging theories during a certain period. With 'paradigm shifts' the scientific approach as such does not change, but the beliefs and the demarcation in the observing eye of the beholder change from perspective, hence the underlying theories change too although phenomena stay the same, for example: The heliocentric view of the universe against the flat earth changed, but not the stars and planets themselves. People changed position and moved on with the new theory as leading principle.
Portal	is a web functionality that presents information from multiple sources in a unified way. Portals offer services such as search features, e-mail, news, prices, information and entertainment.
Progress	is technology-induced growth of knowledge to an improved or more developed state due to the interplay between technology and social processes of this technology's use.
Repository	is a place where things are stored and can be found.
Rings-of-Universities	are cooperating universities concentrating on their core curricula. The core is put as 'brand' to demarcate the several institutes. The university partners behave as 'node' in a ring.
Scholasticism	is a method of learning mainly taught by the academics of medieval universities in the period of 1100 to 1500 AD. The synthesis of Greek Philosophy and Christian Doctrine is the heart of scholasticism.
Seat Time Activities	are the activities logged with timestamps per action when a user is connected to the Blackboard VLE.
Seat Time Duration	is the session period that a user, the end-user machine, is connected to the Blackboard application server.
Seat Time Moment	is the point-of-time or moment-of-the-day that a user, end-user machine, is connected to the Blackboard application server.
Shared Services	refer to the provision of services by one department of an institute where services previously were available in more departments. Funding and resourcing of services is shared and the providing department effectively becomes an internal service provider.
Sigmoid Curve	is an S-shaped curve or growth curve or logistic curve indicating lifecycles of organisms, of products, of businesses and of logistics. The exponential attribute is important because it suggests the curve is driven by a factor representing the 'rate

of change'.

Special Services are complementary services and products that focus on the multiple architectures of portals and repositories.

SPSS stands for Statistical Package for Social Sciences, which is a computer program used for statistical analysis. Scripts composed from its SPSS syntax can automate complex and repetitive processes.

SQL stands for Structured Query Language, which is a database computer language designed to manage data in relational database management systems such the Blackboard database. SQL includes data querying, updating, creating, modifying, accessing and controlling.

Stages Model for Educational Technologies is the composition of four successive educational technologies: 1) computer based training, 2) online learning, 3) learning on demand and 4) learning mall. ICT uses or literacies correspond with the educational practices. The timespan represents a period from the 1980s to 2040s; from the first widely used computer applications within education to the upcoming implementation of learning malls, where desired or required learning objects can be obtained online.

Sustainability is the capacity to endure using the earth's resources, without causing damage to the environment.

Switch is the changeover to a new technology that disrupts a standing organisation, to modernise its working and learning environment and give way to further development of the organisation's knowledge.

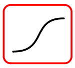
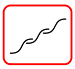
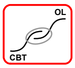
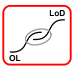
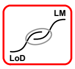
Users' Uses stands for putting something to work, such as a tool, skill or building to a particular purpose. With the VLE logging data such uses can be determined, but not the behaviour and thought behind the action.

Valorisation of Knowledge means a more often and faster transition of research and engineering thoughts or ideas into innovative applications through market principles.

VC stands for Virtual Community, an actively used Blackboard organisation.

VLE stands for Virtual Learning Environment, which is a collection of integrated tools enabling the management of online learning, providing a delivery mechanism, student tracking, assessment and access to resources.

Pictionary

	Scholastism
	Enlightenment
	Sustainability
	Financial matters, subsidies and funds
	Society, wisdom of the crowd, group work
	Educational technology, i.e. information technology playing substitution roles, transitional roles, or transformative roles
	Teacher-led pedagogy
	Literature search
	Educational practice
	Strategies of management, education and implementation
	Father Time ruling lifetimes and lifespans
VLE	Virtual learning environment
	S-shaped curved growth pattern
	Minor S-shaped user curves following the system's growth curve
	Switch from local support to shared services
	Switch from shared services to special services
	Switch from special services to open services

ACKNOWLEDGEMENTS

'Very gratifying,' said Professor Albus Dumbledore mildly. 'We all like appreciation for our own hard work, of course …'

From Harry Potter and the Half-Blood Prince by J.K. Rowling (Rowling, 2005)

I have been working in the field of information technology (IT) for nearly three decades. Office automation and business administration are topics that have returned daily, with every project that I carried out I realised that the people involved were the keys to a successful project. Often officers with key functions were involved, although they did not always know why their superiors had asked them to do the project. I had to make clear to them that they were the owner of some problem, making them a problem-owner has been the main challenge of my project leadership. With a background in electronic engineering, I am used to thinking of components in terms such as capacitors and resistors. Hence, I was comparing the project-related people with such components. Resistors are persons who actively resist project ideas, who throw up new academic discussions and theoretical thresholds. Capacitors hold potential for electronic circuits, and according to my view, building human capacity holds potential for project outcomes. Capacitors and resistors are passive components but once triggered by actions or events they follow the rules of natural curves and so do people and organisations. This was my belief. The works of Richard Nolan concerning IT-growth in corporations corroborated my beliefs. Nolan has written a number of Harvard Business Review articles about management of Information Technology, and is originator of the information technology 'Stages Theory', a widely used management framework for IT base-lining and planning.

In 1996 I switched to the field of information and communication technology in education (ICTE). I entered a domain where the people involved had degrees in education, in psychology, in other sciences and with other backgrounds. They handled information and communication technology (ICT) as tools they used to support educational processes; the *substitution process*. Substitution enhances an educational process but does not change it. For instance in a virtual learning environment (VLE) the good old lecture notes can be digitised and presented online. In the last decade, however, small shifts in educational processes have begun

to take place. New electronic processes have been assimilated within the curricula such as electronic communication between lecturer and student, and virtual community building. Such shifts implied minor changes in the attitudes of teachers.

I was a bit surprised that applications and tools such as mathematical, graphical, design and assessment software were not considered to be information and communication technology in education (ICTE). When I started to read articles, proceedings and books, about implementation strategies concerning the development of ICT in educational institutions, I had the impression that history was repeating itself, for me it seemed that ICT growth in education was behaving similar to the growth of IT in organisations, something which had been extensively researched by Nolan, Rogers and many others from the nineteensixties onwards.

In the ICTE domain my beliefs remained the same as those in the IT domain. I was very lucky to work with Professor Wim Veen when rolling out an innovation program of ICT in Education at Delft University of Technology. His inspiring ideas and creative attitude have always brought out the best in me.
When I was stimulated to do a thesis in the field of ICTE by my former, and now retired, executive officer Jan van Staalduinen and direct superior officer Cock Huizer I finally got this chance to cross-use my experiences from the IT and ICTE domains. Therefore I am indebted to Jan and Cock and cordially thank them for giving me this great opportunity to organise my work and study with flexible working schedules. I am very proud and honoured to have Jan and Cock stand by me as dissertation defence assistants, or paranimfs as we call them. Of course, I was very fortunate to have Wim Veen as my inspiring supervisor. I thank him for his belief in me from the start. It was due to several free discussions with Wim that I convinced myself to explore the influences of technology on education in general and the uses of the virtual learning environments in particular.

I would like to thank the many colleagues who supported me during this intensive but inspiring voyage. I want to express sincere gratitude to Dennis Pauw who helped me out, and with setting up the SQL database queries. Every time I apologised for wasting his precious time, he wiped it away with the words: 'I'm interested too, you know'. Next, I would like to thank Mark Schenk for giving me access to the Blackboard virtual learning environment in the very beginning of my journey when I had to explore the possibilities of its logging data. The special permission of DUT's legal officer was needed because of privacy regulations. It took one year to obtain an agreement on access and scientific uses of the Blackboard data for the DUT case only. Such a protracted procedure was impossible to follow for the other institutions from which we collected data. I had to find an alternative way to gather data on VLE use at other institutions, finally I was able to collect anonymous data without context. I would like to thank Willem van Valkenburg for contacting associates within his human network and helping me to obtain data. I would like to thank Jan Paul van Staalduinen for many philosophical discussions in my early days as PhD student. Of course, I must thank Pieter de Vries for being a stimulating colleague who had already done a PhD four years earlier. As a prize for his doctorate efforts, he nicked my 'TU Delft signatured ecologically sound coffee cup' with the remark that I would get it back in return for handing over a tangible dissertation. I owe special thanks to Jacco Lammers who inspired me with multiple high-level interactive discussions and helping me out with my dissertation design and pictorial graphics. I would also like to thank Ayla Maagdenberg for working my historical perspective storyboard into a beautiful comic with such a charming Father Time and Mother Nature and Charlotte Kobus for designing the appropriate cover for my opus magnum. I would like to thank Miranda Aldham Breary for proofreading my dissertation, and correcting my poor English, it must have been hard work.

The organisations I contacted, and which delivered the so very important empirical data for my research treated me very kindly. I would like to thank Dick Roest and Mihn Le from Delft University of Technology, Victor Maijer from the University of Amsterdam, Henk van Rijssen and Wilco Foppen from the Regionaal Opleiding Centrum Midden Nederland, Chris Japing from The Hague University, Marco Gorissen from the University of Maastricht, Jos Jans from InHolland University, Ineke Janssen and Martien 't Hart from Radboud University, Klaas Haasjes from Windesheim University, and Patrick Klaassen from Leiden

University, all of whom delivered lots of raw blackboard logging material. I would like to thank Carlo van Haren from Stoas who helped me with the MS SQL statements.
I am very grateful for the support I received from Ahmar Abbas, a former vice president at the Blackboard ASP (Application Service Provider), who believed in my project, and Justin Tan at the Blackboard Corporate Counsel who arranged the possibility for me to investigate the anonymous data and Jeff Boulier who made the logistical efforts required to deliver the vast amounts of logging data to me.

Doing dissertation research is impossible without the unconditional support of the home front. I owe my lovely wife Petri for her infinite love and enduring care and wish to express my deepest gratitude. She has stood by me throughout and always believed in me and of course I must thank our children Joey, Dionne, Erik, Suzanne, Elise and Tom for putting up with an absent of daddy for the last seven intensive years. I could not be a strict parent because enforcing the observance of rules would take me too much time. Still I am confident that their growing-up-in-liberty was not bad for their spirits :-)

Delft, December 2009,
Piet van der Zanden.

1 DESCRIPTION OF THE STUDY

The most difficult part was deciding where to begin read.
The bookshelves extended out of sight, their information
stretching as if to eternity.

From Elantris
by Brandon Sanderson
(Sanderson, 2005)

1.1 HIGHER EDUCATION IS UNDER PRESSURE

Various developments have significant influence in the shaping of today's higher education, such as governmental regulations and education subsidies (Laurillard, 2002; Mora, 2007; Vossensteyn, 2007), societal influences such as jobs and knowledge (OECD, 2000), information and communication technologies (Garrison & Anderson, 2003; Khader & Barnes, 1999; Laurillard, 2002; Senn, 2003), and educational policies (Plasterk, 2007). These multi-faceted influences give rise to enormous pressures on the daily operations of a university.

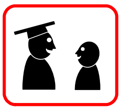
The pressure arises from ever diminishing subsidies from government (Laurillard, 2002; Vossensteyn, 2007). In the Netherlands, since most Dutch higher education institutes are being heavily dependent on state subsidies, the financing system has been tuned to the input-financial model. This model was developed to assign proportional parts of the state subsidy to university's organisational departments. Without alternative funds and given diminishing state subsidies educational processes are pressed as more efficient (Vossensteyn, 2007). The pressure is not limited to money matters. As a major budget holder the government has introduced numerous regulations and interventions (Mora, 2007).

More pressure comes forth from evolving labour demands where having a job for life, is being exchanged for a job hopping culture of short term contracts (Baldwin & Chronister, 2001), where jobs demand knowledge upgrading over increasingly shorter periods where 'life-long-learning' or 'education permanente' is becoming the norm; where the economy requires a higherly educated workforce (Weber & Duderstadt, 2004). The European Lissabon Agreement (1999) called for the European member states to deliver a higher number of educated people. According to the agreement fifty percent of the European population should have had higher education. Such an increase in student numbers is disproportionate with the diminishing subsidies in many European countries.

When higher education became available for the masses in the 1960s it meant changing demands and attitudes as more students from broader social classes entered universities (Wissema, 2005). The universities responded with a competitive attitude to obtain more students for a greater share of the national subsidy, which is assigned proportional to student numbers (OECD, 2000; Vossensteyn, 2007). The universities also started to offer a wider variety of master education tracks to meet the broader demands of the students. Universities in some countries have begun to offer flexible bachelor tracks to give a student the opportunity to choose non-curricular courses referred to as minors, worth up to 30 education credit points (ECTS), and which provide for a more personalised learning track (Plasterk, 2007).

Even more pressure on the universities comes from technology (Laurillard, 2002; New Media Consortium & Educause, 2008). The use of information and communication technology (ICT), is spreading into every corner of our society. Modern ICT has changed the logistics of businesses (Foster & Kaplan, 2001), it has changed the environment of the workforce with computers and Internet at hand (Stevenson, 2003), it has streamlined communication patterns within and between companies (Tewoldeberhan, 2005), it has supported training of human resources with e-learning possibilities (Vries, 2005), and it has allowed the conversion of almost every financial paper-based process into an electrical one (New Media Consortium & Educause, 2008).

Today's children do not know a world without technology (Prensky, 2001). Technology, which is so obviously present, so naturally available, is used for communication amongst friends, for exploring games to have fun, and for zapping to follow multiple television channels simultaneously (Prensky, 2001; Tapscott, 1997; Veen & Jacobs, 2005; Veen & Vrakking, 2006); because they grow up with such ICT our students wonder why education is not making more extensive use of ICT, and consequently they enforce the pressure with their assertive attitudes.



Yet more pressure on the universities comes from those in the field of education science. Today's education system is still mainly based on teacher-led instruction and controlling attitudes for obtaining a degree (Veen & Vrakking, 2006). The current education system has little space for ICT as means for presenting new pedagogical possibilities (Laurillard, 2002; Oblinger & Oblinger, 2005; Siemens, 2005). The main learning theories, behaviourism, cognitivism, and constructivism, on which the education models of today are built, evolved in times before ICT existed. Hence, they do not consider learning in a context where scarcity of information, communication and presence is vanishing, and where new possibilities for learning are emerging. New movements and ideas that build on learning, which is supported by, or transformed through ICT, are developing these ideas and are in collision with the instructional establishment that has existed for centuries (Siemens, 2005; Veen, 1994).

1.2 PROBLEM STATEMENT

The pressures lead us to the problem statement of today's higher education:

Higher education is directly and indirectly subjected to pressures of diminishing subsidies, increasing student populations, labour demands, proliferation of technology, and new educational approaches and practices. Higher education must change to cope with such pressures.

How should universities respond to such pressures?
To date, universities have taken a number of measures to cope with diminishing subsidies, such as reorganising the secondary, education support, processes to allow them to operate as more efficient instruction factories. staff must work more intensively, and the students must study more efficiently to shorten their study terms. Targets have been defined as objectives to push the universities forward and to measure its progress over the years (TU Delft, 2003).
The European Community is shaping itself a position to compete with other leading world nations in response to the internationalisation and globalisation of markets, of trading, of business, of professions and of production. Consequently, the universities of the European Community have begun to organise international mobility programs for students where educational tracks are synchronised at bachelor and master levels and equivalent study credit points can be obtained (Weber & Zgaga, 2004).

Computers, as support for education processes, were introduced as early as the personal computer (PC) became available. In the 1980s the PC was used for 'computer based training' (Alessi & Trollip, 1991; Collis & Moonen, 2002; Frencken et al., 2002; Leigh, 1998; Rosenberg, 2001; Ven, 1998), and since the second half of the 1990s 'virtual learning environments' (VLE) were introduced into higher education. The Internet and server-based communication possibilities now available have been gradually set to work within the universities to support the education processes (Cross & Hamilton, 2002; Goodman, 2002b; Rosenberg, 2001; Steeples & Jones, 2001). Virtual learning environments are now widely used within higher education and many universities are starting to see their limitations for new educational practices, hence, new policies are being put in place to further integration of ICT for learning.
Education institutions want to expand the, thus far substituted, ways of learning based on the virtual learning environment with fresh physical environments to transform standing educational practices. Learning centres are an interesting example, and physical expression of such an environment, with encompassing technology for new pedagogic models. A learning centre is a modern building equipped with a multitude of ICT and flexible to use rooms to create several sorts of learning spaces for group learning and problem based learning (Oblinger, 2006). As a second example; the scientific universities are introducing science parks on their campuses that are incubator areas where entrepreneurs and students can valorise university knowledge into market products.

We may say that the pressures are forcing the universities to shift the primary teaching and learning processes towards student-led approaches (Laurillard, 2002). The role of ICT seems to be a catalyst (Cross, 2006) in facilitating the upcoming changes within education, ICT enables the processes to become more efficient, and changes the very nature of those processes (Veen & Vrakking, 2006). Information and communication technologies are changing the way in which we deal and process information, it is changing the way we communicate and share information, and it is changing the way we create new knowledge. Hence, it changes the way we learn and for such reasons higher education is forced to change its position correspondingly. It has to change its position as it has done historically. It is said by Tony Bates that the Internet brought about a revolution which is to be compared with the printing press (Bates, 2000). If we consider the above-mentioned pressures and the several developments, may we then assume that we are somewhere around a swivel point on our way to the next seminal change in history, such as Bates claims? Are the afore-mentioned developments signs on our way to a next generation university? Our environment

is changing and business processes are too, why should the education systems remain the way they were for centuries with their teacher-led instruction and controlling attitudes? Are we in the changeover period from a (post) industrial society to a creative society where social capital is an important production factor (OECD, 2000)?
Of course the existence of such a changeover point is disputable and dependent on the observer. We may use the ‘Sorites Paradox’ (Hyde, 2008) to explain the vagueness in indicating such a possible changeover point. The paradox arises from vague predicates, and as an example, we will take the heap-of-sand paradox. When from a heap-of-sand each time a grain of sand is removed, we can still call the heap a heap-of-sand. Only when grains are continuously taken away one after the other, the heap will steadily shrink and we will reach a stage where we can no longer call it a heap-of-sand anymore, but where was the changeover point? If we assume that such vague predicates also count for today’s higher education we have to find suitable answers to help the universities cope with the pressurised situation, to take position to move forward, and to gain from the developments: but how can we find such answers?

Numerous authors have indicated and described the influences that have played a role in the evolution of higher education in the last four decades. This study, however, will focus on educational considerations and the uses of information and communication technologies, which have been, and still are, affecting the primary processes of teaching and learning. In order to get a feel with those influences we executed a literature search.

1.3 Literature Search

The body of literature about educational technology is huge and to start our search we initially concentrated on scientific databases. Several bibliographic databases exist for many different scientific domains, such as WebSPIRS and the Cambridge Scientific Abstracts (CSA). For our educational technology field as part of social sciences we used the Education Resources Information Center (ERIC) database. We chose ERIC because it holds journal articles from all sorts of journals, both high ISI rated journals and low cited journals. Moreover, books and conference proceedings are also available online or at least the references to them. ERIC holds more than 1.2 million items indexed since 1966, and because of this large number we had to execute many search queries, which continuously came up with unsatisfactorily large result lists.

With the problem statement in mind we have selected the following keywords ('within quotes') adressing 'higher education', where 'educational technology' must have its influences, hence, we aimed at the primary education processes and sought for 'innovation' within the 'educational practice' and based on 'educational technology', such as the 'computer' for 'computer based training', and the 'network' for 'online learning', 'virtual learning environment' and 'repository'. Next, we have sought for 'implementation strategies' and 'diffusion' of educational technologies that led to 'educational change' for 'teaching and learning' practices, which were designed on standing 'learning theories'.

In response to the large result lists the keyword 'higher education' was set as the top level filter while 'educational technology', 'educational practice', and 'educational change' were set as second level filters. The combined keywords within quotes were used in combinations with other combinations and as single keywords. The result lists were used to construct an overview of the educational technology field at the beginning of our study. Abstract descriptions of the result lists were thus investigated. The result lists for ERIC were presented in batches of 50 records each. The full abstracts of one or more batches at a time were studied and dependent on the abstract, the contents of the paper, article or book were scanned or retrieved. Keywords were noted to give an overview and rough insight of the educational technology field. To demarcate the field we followed the definition of Randy Garrison, which is: 'educational technology are those tools which are used in formal educational practice to disseminate, illustrate, communicate, or immerse learners and teachers in activities purposively designed to induce learning' (Garrison & Anderson, 2003). With such definition in mind many abstracts from the result lists could be dismissed. After having scanned thousands of abstracts an overview emerged of the domain of educational technology from the ERIC database. We could discern three major streams of publications emerging during the literature search execution, which were:

- **educational practices with teaching and learning approaches**
- **applied technologies within such practices**
- **implementation strategies to set such educational practices at work**

The division of results over the three streams are presented in Table 1. To complement these first insights in the educational technology domain additional strategies were followed to understand which educational technologies had received serious attention in the last five to ten years. First we chose to visit conferences of the International Association of Management of Technology (IAMOT) for 'change management' issues and 'innovation theories' concerning information technologies from the corporate sector. We also went to conferences about educational technology and e-learning such as the Educational Media conference (EdMedia), Online Educa Berlin, and the International Educational Technology Conference to corroborate our overview of the literature trinity of 'educational practice', 'applied technologies' and 'implementation strategies'. The conference programs were carefully screened for interesting key-note speakers and speakers with related sessions for approximately the last five years. The sessions were visited and about 25 of the speakers were interviewed in a brief but structured way focussing on topics and issues related to our research. The interviews were focussed on educational practices that are about to become dominant, the technologies such practices are built on, and how such practices were pioneered and diffused over education and corporate institutions. The references of the speakers' articles were traced and the conference proceedings were sought for related issues. EdMedia is part of the Association for the Advancement of Computing in Education (AACE), which also organises the E-Learn and SITE (Society for Information Technology & Teacher Education) conferences. AACE has its own Education & Information Technology Library (Ed/ITLib), formerly known as the AACE Digital Library, which was also examined. We also subscribed to online services such as Table of Content (ToC) alerts of journals, magazines, and online communities. Visiting the conferences gave the opportunity to meet people with a future message about upcoming educational technologies or future educational practices. One simple strategy for future researchers is to assess how audiences react to future messages, such reactions allow us to gauge feelings and determine if the speaker's message is 'far out' or a 'hot topic' (Glenn, 1994b).

Table 1: Frequencies of Search Queries for Higher Education in ERIC Database.

Higher Education	***Educational Practice***	***Educational Technology***	***Educational Change***
	9414	***16374***	***23138***
Innovation	*472*	*1415*	*1909*
Diffusion	*26*	*117*	*108*
Computer based training	*80*	*447*	*89*
Online learning	*267*	*1477*	*246*
Learning on demand	*36*	*141*	*109*
Implementation strategies	*137*	*242*	*492*
Teaching and learning	*2266*	*3790*	*2735*
ICT in higher education	*36*	*154*	*35*
Distance education	*412*	*2943*	*772*
Virtual learning environment	*45*	*246*	*50*
Repository	*5*	*26*	*8*
Computer and network	*50*	*470*	*91*
Computer	*967*	*7279*	*1431*
Network	*170*	*734*	*420*
Learning theories	*515*	*368*	*365*

1.3.1 Educational Practices

Educational practices as one main stream within the educational technology literature combine the fields of instructional theory and design (Reigeluth, 1999), pedagogy for teaching and learning (Moore, 2000), and educational psychology or learning theories (Slavin, 2005). Discussion of how instructing practices are developing given the educational technologies to hand is an ongoing debate (Spector, 2001). Several definitions have come along, such as online learning (Gibson et al., 2006; Paulsen, 1995), virtual learning (Duin et al., 2001; Prestoungrange et al., 2000), technology enhanced learning (Goodyear, 2001; Steeples & Jones, 2001), e-learning for both face-to-face settings as distant learning (Baets, 2001; Brennan et al., 2001; Brown & Duguid, 1996; Collis & Moonen, 2002; Goud, 2001; Lansink, 2001; Lowyck, 2001; Rosenberg, 2001; Telematica Institute, 2001a, 2001b), and of course blended learning as a mix of offline and online educational practices (Fabian et al., 2007; Motteram, 2006; Smith & Hermann, 2007; Vaughan, 2007).

In general, there is agreement that e-learning is the catalyst for changing the whole model of learning for both formal and informal ways (Cross, 2006). If we look back at how the first technologies such as radio and television were applied, it was mostly for an efficient transportation of one-way communication such as lectures and classroom lessons (Spector, 2001). The form of instruction remains the same and the learning remains the same. The technology was only used for support and broadcast the instruction, what did change was our knowledge about the learning process. Three main learning theories 'Behaviourism' (Pavlov, 1927; Skinner, 1947, 1950), 'Cognitivism' (Gagné et al., 2004; Piaget & Inhelder, 1969), and 'Constructivism' (Bruner, 2004; Gagné et al., 2004; Piaget & Inhelder, 1969) began to gain ground from the 1920s onwards (Ertmer & Newby, 1993).

When two-way communication became possible (Gayle et al., 2006) with the use of email functionalities within all sorts of systems a more efficient flow of, for instance, peer reviews, sending papers or other electronic documents was achieved, but still the learning paradigm did not change (Cafolla, 2006). Examples of technology supported ways of learning where parts of (existing) learning materials are transposed into digital artefacts, include tutorials on CD-Roms or on the web (Rosenberg, 2001). Parts of the processes were converted into a digital way of work and these were taken over by the computer, such as mathematical simulations. Converted ways of learning are called 'Substitution' (Collis & Moonen, 2002; Fullan, 1999; Wolf, 1998).

Nowadays educational practices are increasingly based on learning scenarios with embedded technologies, which could not exist if the technologies were not available, such as an online learning setting with underlying electronic communication, something not possible without the e-mail, bulletin boards, distribution lists, or chat along an electronic network. These additional ways of learning are called 'Transition' (Upcraft et al., 2004; Wolf, 1998). Completely new ways of learning, based on, as yet non-existant, learning paradigms based on a disruptive leap out of the standing classroom-based setting have not yet been implemented although the learning centre as new educational environment seems to offer huge opportunities (Oblinger, 2006). Such disruptive leaps are called 'Transformation' (Bates, 2000; Brown, 2000; Brown & Duguid, 1996; Fullan, 1999; Veen & Vrakking, 2006; Wolf, 1998).

Concluding Remarks for Educational Practices

In the last century the instruction and learning processes remained about the same while the three main learning theories, behaviourism, cognitivism, and constructivism, were formed to help us understand such processes. When educational technologies were introduced in the 1960s onwards they were set to work to convert logistic and presentation processes followed by learning practices built on communication technologies. We think that the transformed ways of learning will become the educational practices of tomorrow. According to several studies learning will become a permanent activity, one that continues for ones working life and beyond, four or five year tracks followed by one employer and a job for life is becoming a thing of the past (Brown, 2000; Brown & Duguid, 1996; Oblinger & Oblinger, 2005; OECD, 2000). The work practices of tomorrow will probably be supported by a permanent learning infrastructure able to help the knowledge worker at any time, in any place and at their convenience. Consequently, today's and tomorrow's educational system has to prepare students for such a working environment, they will have to 'earn & learn'. Educational practices based on information and communication technologies are described in more detail in Chapter 3, a possible future practice is presented in Chapter 7.

1.3.2 Applied Technologies

The applied technologies, another main stream within the education technology literature, combine the fields of instructional systems design (Ledford & Sleeman, 2002), human performance technology (Pershing, 2006), educational technology (Garrison & Anderson, 2003), information technology (Senn, 2003), and telecommunication technologies (Khader & Barnes, 1999). Many tools have been introduced within educational practices such as computers, multimedia, learning software, assessment software, networks, games, simulations, beamers, videoconferencing, interactivity boards and calculating devices. All such technologies have replaced the older ways of work with standardised applications, the computer replaced the text editor which replaced the typewriter, and the interactivity board replaced the whiteboard which replaced the blackboard and the handheld replaced the calculator which replaced the slide rule which replaced log tables (Frencken et al., 2002; Gibson et al., 2006; Goud, 2001; Kommers, 2005; Leigh, 1998; Paulsen, 1995; Wolf, 1998).
E-learning as an infrastructure has been introduced within private training institutes and the corporate sector to achieve cost efficiencies (Moonen, 2003; Vries, 2005) and, for instance, within the defence department to train soldiers in a far away place or to promote agencies with satellite consultation bureaus (Gagné, 1962). Through the years the systems have grown from single-user computers and terminals to multi-user environments where collaborative design and team work has become obligatory. Over time the infrastructure has been developed into compound networked systems designed to support the online learner and worker (Castells, 1996; Clark, 2003b, 2003c; Rosenberg, 2001).
Today's young ones, our new workforce, are growing up in close familiarity with such everyday IT and ICT based commodity goods as the remote control, the mobile phone, the calculator, and of course the computer, with the possibilities these tools give to communicate in a virtual world (Brown, 2000; Brown & Duguid, 1996; Oblinger & Oblinger, 2005; OECD, 2000) and exchange of all sorts of digital objects (Rushkoff, 1999; Veen, 2000; Veen & Jacobs, 2005; Veen & Vrakking, 2006). Information and communication technology, as such dominant societal phenomenon, is having an enormous impact on educational practice as it exists today (Brown, 2000; Wolf, 1998). New technologies which showcase the competences of the modern student are slowly being embraced by higher education, such as the portfolio system as an additional way to make assessments or for electronic showcasing executed assignments (Tartwijk et al., 2003). Moreover, today's innovative teachers are mixing online functionalities within their standing practices to achieve blended approaches to learning (Smith & Hermann, 2007; Vaughan, 2007).

Concluding Remarks for Applied Technologies

The applied technologies used within educational practices have changed over time and continue to change. In the 1960s vast mainframe computers, rigid inflexible systems, began to be used in the world of education. Such legacy systems were technologies which had to be institutionalised to fulfil their electronic jobs; a complete support and maintenance organisation came with it. Such organisation-led structures were the main influence and held the mandate for setting the technology to work. In time the miniaturisation of electronics led to ever shrinking devices from the mini-computer to PC to a handheld device allowing the end-user to take over the choice of what technology to use and how and where to use it. Such a user-led way of using applied technologies demands a different institutional infrastructure. Better put, students are urging the universities to keep on modernising their legacy technologies. The evolution of applied technologies within education are described in more detail in Chapter 3. We will describe emerging technologies for a possible future educational practice in Chapter 7.

1.3.3 Implementation Strategies

Implementation strategies, the third main stream within the education technology literature, combine the fields of change management (Hayes, 2007), innovation management (Afuah, 2002), and education management (Coleman & Earley, 2004). The literature results mainly represent pilot studies, try-outs, practicals, and policy issues, coupled with advisory reports that are based on all sorts of studies applying the technology within educational practices for innovation projects and organisational pioneering. Such pilot studies are worth exploring to determine what 'thresholds' there are, what 'barriers' need to be overcome and what 'resistances' might be met when a technology is brought into the classroom.

In the 1980s the computer was approached with confidence, and liked for its huge potential within higher education (Collis, 1997; Veen, 1994), however, computer applications and their possibilities were always under discussion; they could not replace the teacher. Furthermore, there was always a lack of software, of sufficient hardware, and of support due to the ever continuing development of faster systems, increasing memories and better interfaced devices (Brown, 2000). Still interest in using computers in educational practice increased and many publications appeared about the potentials of the computer despite the slow changes in school's attitudes and teachers' resistances to their use (Veen, 1994). The computer was slowly brought into action within the primary education processes where the students used a computer as a calculator within mathematical based courses, and as a simulation application within mechanical and design programs (Ven, 1998). From the 1990s on office automation became a commodity used to support education processes and in parallel students increasingly got the opportunity to make use of PCs to do their homework in text editors, spreadsheets and on drawing applications. Classrooms were wired through Local Area Networks (LAN's) to share file and print services and with the LANs electronic messaging became available. Lecturers could change their way of presentation, began giving instructions for homework digitally and expected the students to also work digitally. Parts of, and even complete, lectures were distributed on CD-Rom and provided with pedagogical settings. Following these faculty developments the university departments began strongly to centralise supporting facilities, such as network infrastructures and office automation. Those centralising ideas evolved into the shared service centres of today (Wissema, 2005). Complete backbones at high speed were installed on campus and in the late 1990s every workplace was wired (Bates, 2000; Nolan, 2000; Zanden & Veen, 2003b). Office automation has been streamlined and standardised, and every member of the university population, lecturer, staff member and student, can use a complete set of office automation tools, such as text editor, spreadsheet, presentation software, drawing software, internet browser and communication tools according to the license deals made by a university (Vredeveldt, 1997; Zanden & Veen, 2003b). All such technologies were essential for office automation and because the tools were integrated within the daily work environment such tools were easily adopted within educational practices (DeSanctis & Poole, 1994; Laurillard, 2002).

In parallel the Internet became popular for information presentation and retrieval. The world wide web was set to work for the distribution of lecture materials and was becoming a common infrastructure for online courses (Bates, 2000; Brown, 2000; Clark, 2003a; Collis, 1997; Fisser, 2001). Alongside, communication techniques such as email, distribution list, and community building software were introduced within higher education (Collis & Moonen, 2002; Rosenberg, 2001; Rossett, 2002; Zanden & Veen, 2003b). Today we do not speak just about IT from plain information technologies but more about ICT. This 'C' for communication brought new possibilities for education. Communication technologies were introduced within higher education to support dialogues between the student and the lecturer and between students. The two-way simultaneous communication modes for several users provided a crucial extension to existing educational methods and processes (Kommers, 2005). Today, even dialogues between people and machines are possible where social software systems take the place of people to present and select information (Siemens, 2005).

Concluding Remarks for Implementation Strategies

A discussion of ICT implementation strategies brings to ligth the effects, resistances and hindrances of institutionalising the several sorts of technologies used within educational practices. It was striking that there are so many publications reporting studies with similar objectives, such as uses of single applications on PCs or the web, of courses where online communication supports the project assignments, of VLEs with course information online and its completeness for the student, of exploring uses with social software technologies, and even of setting to work game technologies. We think it is time to stand on each others shoulders as Bernard of Chartres used to say in the 12th century "We are like dwarfs on the shoulders of giants, so that we can see more than they, and things at a greater distance, not by virtue of any sharpness of sight on our part, or any physical distinction, but because we are carried high and raised up by their giant size."

It is our objective to take the current state of implementation strategies one step further and to elaborate on future educational practices based on emerging technologies or new technologies to come.

1.3.4 Concluding Remarks

To conclude the literature search one can say that it is not the old learning content that just needs to be digitised, the learning materials and environment need to be transformed to reach more heterogeneous students, to meet with the computer literacy of the coming workforce, to create challenging assessments which fit authentic assignments, and to support portfolio issues to fulfil the continuing learning attitudes required for today's life-long-learning (Laurillard, 2002; OECD, 2000; Plasterk, 2007).

The education technology competence of teachers is an important issue because yesterday's teacher can hardly set and tune a virtual environment, facilitate its functionalities and cope with the technological innovations to make it work for educational practice (Sjoer et al., 2007). Today's teacher must be able to carry out these tasks. At the same time management faces challenges such as lack of finances to keep the technical environment in a state-of-the-art condition, and continue their search for a vision about how their institute must facilitate the learning process to be ready for future educational practices. Sjoer and others argued that the current learning activities and practicals of students who learn from cases are a bit off-side from real practice. There are authentic projects which have been proven to make more sense and to motivated more students (Sjoer et al., 2007).

In the Information Age 'life-long-learning' or 'education permanente' is becoming an imperative (OECD, 2000) and with the information and communication technologies entering the primary processes of higher education it becomes clear that a revolution is at hand. A vision or master plan for higher education is desperately needed to be ready for the future (Ikenberry, 1999). This leads us to the research questions.

1.4 RESEARCH QUESTIONS

Educational technologies have affected the course of higher education in the last four decades. According to the literature search, educational practices and applied technologies strengthened each other for exploring new ways for teaching and learning. We wanted to question the pressures, due to such technologies, which penetrated education and how these pressures are related to educational views and insights. We will research how the uses of educational technologies are evolving and how universities should cope with further technological advancements changing the traditional ways of teaching and learning. We will try to catch the processes of integration of technology within the primary education processes, to recognise possible patterns that may help universities to develop strategies for future policies. This leads us to the Main Research Question:

How might higher education cope with the current and upcoming pressures of technology on education?

To answer the main research question we have to specify it into sub questions to make the research question operational and executable. Sub questions will help us to answer the main question in a structural way. If we want to formulate design principles for the next generation university, we must have insight into how today's university got its shape and what developments have played an important role in the shaping process. If we consider the educational technologies of today we can easily imagine that we are underway; on a regular basis new information and communication technologies have come onto the market and most of them have been introduced within educational settings. It is not so easy to see where we came from and where we are going to when we consider such educational technologies. It is even harder to forecast if such technologies will change or transform standing educational practices.
To give meaning to our gained insights about educational practices and applied technologies, as two of the three main literature streams, we have to place them on the timeline. It is clear that we can only position educational technology on the timeline when we know about its history, and intriguing as it sounds make some assumptions about its future. When we can pinpoint the course of higher education from the past then we may be able to follow its course into the near future.
With such arguments in mind we want to create an image of higher education from its very beginning in the early Renaissance through the radical times of Enlightenment until today where we supposedly are on our way to a next radical shift in history. It happens to be that we are in the middle of a process where scarcity of information, scarcity of communication, and scarcity of presence are vanishing due to all sorts of technological innovations, and where Western countries and developing countries are merging into more equally growing economies and one man or woman can no longer have a complete overview off 'all known knowledge' as Leonardi da Vinci had in his time.

An exploration of higher education's evolution is very interesting for drawing a timeline for universities from the past to tomorrow. With the creation of a higher education timeline a lot of new literature becomes relevant. We discovered many sideways and crossroads within other domains, such as sociology, information technology, philosophy and besides this everything has its own developments in history. Therefore, the first research sub question was aimed at recognising the developments which have been playing their part in the shaping of the higher education institutes. This led us to the first research sub question:

A. What developments have had or have an influence on higher education?

The literature search concerning the developments related to research sub question A is presented in Chapter 3, where we will gain an insight into where education technology has brought us today. Consequently, we wanted to determine how the today's technology is used. According to the literature the Blackboard VLE has become the dominant technology used within higher education in Western Europe and the United Stated (Bradford et al., 2007; Falvo & Johnson, 2007)

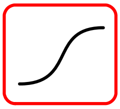
To give meaning to the implementation strategies as the remaining third main literature stream we want to descend from the 'big picture' of research sub question A down to the 'small picture' of uses of the Blackboard virtual learning environment (VLE). The big picture positions the educational technology on a timeline while the small picture aimed at the empirical data of the VLE to determine if the educational technology has evolved according to corporate innovation theories, which are described in the theoretical framework of Chapter 2.

VLE

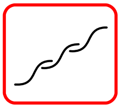
Our unit of analysis was demarcated to the current dominant VLE which is the Blackboard VLE at the institution level. We wanted to know how the VLE was embraced by the higher education institutions, and how the growth and diffusion took place within the institution. Next we wanted to know how the VLE is used by the teachers and students, and if their uses followed certain patterns. Such led us to the second research sub question and its two connected hypotheses:

B. How is the Blackboard VLE used within higher education?

With the help of two hypotheses we wanted to find out if there is a connection between the evolution of universities as synthesised from the literature search (sub question A) and the discrete VLE logging data of research sub question B. An explorative case study together with a quantitative analysis, presented in Chapters 4 and 5, will help us to answer research sub question B. The two hypotheses are described in Chapter 2.



Hypothesis 1:
Implementation of VLE educational technology will grow along an S-shaped curve in time



Hypothesis 2:
The uses of the VLE functionalities follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve

We chose to first scrutinise a VLE as explorative case despite the quantitative character of the investigation. The idea was that the explorative case study would give insight into the operation of the VLE or more particular into the way the system logged the handlings of its users. After some initial exploration we discovered that the VLE stores every system's action into its own database records. The challenge was to pinpoint the handlings of the users which are stored together with the system handlings in a sequence of millions and millions of logs. The users' data are derived from the vast logging tables where scrutiny of the logged data delivered a set of applicable items to determine the users' uses. We followed a quantitative approach concerning the logging data looking for similarities and patterns. The hypotheses helped us to determine possible patterns when the results of our investigation were confronted with the innovation theories discussed in Chapter 2.

Once we had insight into today's university's position and how its educational technology is used by testing the hypotheses in a conclusive way (Delnooz, 1996) we were able to move forward on the timeline by elaborating on the outcomes of research sub questions A and B. According to the literature educational technology is on its way reshaping or transforming education completely (Bates, 2000; Brown, 2000; Brown & Duguid, 1996; Fullan, 1999; Veen & Vrakking, 2006; Wolf, 1998): but the primary education process faces serious cultural, social, organisational and psychological barriers (Zaltman & Duncan, 1977), such as resistance of the teaching staff to their new role (Collis & Pals, 2000; Sjoer et al., 2007; Veen, 1994) or mobility, with students from other cultures and countries (Weber & Duderstadt, 2004), or diminishing finances (Vossensteyn, 2007). Because the technology continues to develop into faster and newer hardware and software there remains a shortage of adequate funding, of time for teachers to master the new technology and of staff to support the users (Brown, 2000). What is striking is that the attitudes of the professionals remain a bit out of balance because they want the computer within the classroom and the laptop in the students' backpack, but they do not change the teacher-student relationship and the planning of their courses to fit into other time frames (Veen & Vrakking, 2006).

We followed a future methodology strategy to give meaning to a future educational practice based on today's knowledge. Future methodologies study potential changes for the coming period. Studying the future is a multi-disciplinary examination of change in many major areas to find the interacting dynamics that are creating the next age, as historians are supposed to tell us what happened before and journalists tell what is happening today, the futurists tell us what may happen tomorrow (Glenn, 1994b). .

Following a future methodology, we elaborated on the emerging educational technologies that may be used within possible educational practices in the future. This is described in Chapter 7. Although the future methodology in itself did not produce a completely grounded description for the future, it did give insight into what may happen and for such reason policy, choices can be based on alternative actions. It led us to the third research sub question:

C. What is the new educational technology that will be used in universities?

Considering the possible outcomes of the research sub questions A, B, and C we would be able to describe what policies will fit with such possible future educational practices. It should be policies, which address the readiness for the university in a competitive market dealing with financial pressure, which addresses the pressures relating to life-long-learning, which addresses the readiness of teachers to make full use of upcoming technologies and which addresses education concerning upcoming movements, such as open education resources.

An appropriate policy may consist of several key principles to shape a next generation facilitating university. Such next generation university is not likely to be an institute that dominates and radiates an elite status such as in the past, but rather one that facilitates changing standing processes and implement new ones to face the mentioned pressures and to be ready for the near future. In the epilogue we will elaborate on a next generation facilitating university and its corresponding key principles.

1.5 RESEARCH OUTLINE

The structure of our investigation is outlined and presented in Figure 1; it holds nine steps caught within four phases:

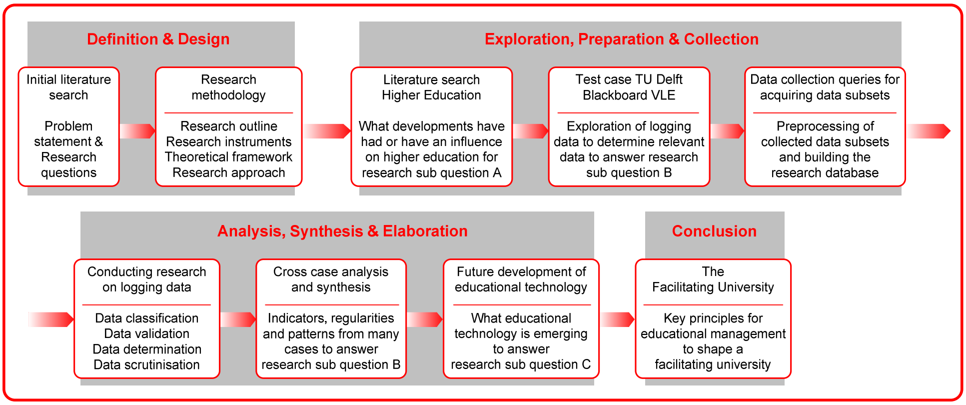


Figure 1: Outline of our Study

1. The first phase 'Definition & Design' was aimed at demarcating the focus of the study. The pressures of finance, society, technology and education define the problem statement and with the help of a literature search the domain of educational technology was explored to formulate research questions leading to an appropriate research methodology and choice of research instruments. The theoretical framework is used to confront the findings of the study.

2. The second phase 'Exploration, Preparation & Collection' was started with additional literature studies aimed at the evolution of higher education and determining what decisive influences have been apparent. As the educational technology domain is not a topic in itself some considerations drawn from philosophical and societal influences were used to answer research sub question A.
Taking the VLE as today's mainstream technology we descended to the detailed level of system logging data to explore how teachers and students use such a technology. An explorative case was carried out to determine what empirical logging data was available and retrievable. Then special collection queries were sent to third parties to acquire data subsets.

3. The third phase 'Analysis, Synthesis & Elaboration' was aimed at processing the collected data subsets. After cleansing the data subsets a special research database was built to conduct the research independently from the institution's systems. The multiple data subsets were classified, validated, determined and scrutinised. The vast number of data subsets was cross-analysed in validating patterns and regularities, and we confronted the outcomes with standing innovation theories to answer research sub question B. Based on the findings an elaboration on the developments of educational technology for the coming years was worked out. This led us to a possible shape for a future educational practice and to an answer for research sub question C.

4. The fourth and final phase 'Conclusion' was aimed at considering the outcomes and findings of our study, what these could mean for future higher education and what possible policy could shape the facilitating university as next generation university.

1.6 RESEARCH INSTRUMENTS

The order and interdependence of the research steps are presented in the research outline given in Figure 1, however, this figure does not offer any guidelines to carry out the individual steps. In this section we describe the research instruments used in this study.

A literature search was executed to gain insight into the domain of educational technology. It was followed with other strategies to obtain relevant information and a consecutive search was executed to position higher education on a historical timeline. Next, case study research was done to explore the empirical data for the quantitative part of our investigation. Data sets from many institutes were examined to help us test and validate the patterns of VLE growth and diffusion, and its uses by teachers and students. The cross-case study had a conclusive character (Delnooz, 1996; Swanborn, 1987) because we confronted the findings with standing innovation theories in Chapter 6. Finally a future methodology was used to guide us as we made assumptions about the next generation educational technology and corresponding educational practices, as sketched in Chapter 7. These future educational practice can be used to support key principles to help university managements set up strategies and corresponding policies for the next generation of higher education, as presented in Chapter 8.

1.6.1 Literature Study

We needed to explore the context in which higher education is found because the research question was aimed at understanding current and coming pressures in higher education. When we considered the position of today's higher education we had to realise that it is just one state somewhere on a timeline in history. To understand how today's higher education got where it is now we had to investigate the influences from earlier times. Today's higher education is the result of a longstanding historical process in which societal, economic, and technological developments have played important roles. We carried out a literature search with the focus on technological and educational developments and their influences on the evolution and shaping of our current higher education systems. The outcomes of our literature search to answer research sub question A provided us with insight in two ways. One, it showed us how higher education institutes grew into today's state and two, it showed us a set of decisive influences.

As far as the current situation is concerned we focussed on the virtual learning environments (VLE) for educational uses because today they are the mainstream technology in higher education. We used empirical data from universities across Europe and Northern America and focused on the Blackboard VLE because that is the dominant one in use today (Bradford et al., 2007; Falvo & Johnson, 2007). Blackboard European Users Conferences were visited to contact employees who were in charge of data preservation at their ASP (Application Service Provider) hosted VLE's. Key persons were approached to sense the probability of reviewing the data and how interesting it would be to produce more general figures for a multitude of institutions. Speakers at the conferences, who were active in investigating the VLE, were also interviewed. Taking the literature and Blackboard VLE educationalists from other education institutes we noticed that none of them had conducted research outside the borders of their own institutions. The conclusion is that no inter-institution comparisons have been conducted. Only a few attempts have be made concerning the Blackboards logging data in the last six years. The explorations were executed to obtain figures about the VLE's uses for educational management (Buelens et al., 2002; Deinum, 2003a, 2003b, 2003c). Thus far no research attempts have been found that investigate patterns and progress and for such reason additional search queries were executed on the ERIC database. The applied keywords were 'higher education' and 'blackboard' combined with 'vle', 'virtual learning environment', and 'educational technology', all in combinations.

The results for the search of the Blackboard VLE are presented in Table 2. A total of 674 results came up for the VLE, reduced to higher education and Blackboard this left a meagre 113 results, which are presented in the table. Another search was done concerning our quantitative approach with the keyword 'quantitative', which gave 34 results for education but delivered no related topics concerning logging data.

Table 2: Results for Blackboard Virtual Learning Environment in ERIC Database.

Virtual learning environment	***674***
+ blackboard	***194***
+ higher education	***113***
Online teaching and learning	*27*
Blended approaches	*11*
Distribution of courses, video, audio	*9*
Policy issues	*7*
Collaborative work online	*6*
Pilot studies	*6*
Motivation issues for first year students	*5*
Online quizzes and surveys	*4*
Library instruction	*3*
Property rights, patents	*2*
Not applicable (the conventional blackboard)	*33*
Quantitative	***4807***
+ educational technology	***307***
+ environment	***34***

Subscriptions at online services were made to stay in touch with the field of educational technology such as the Tomorrow's Professor eMail Newsletter from Rick Reis, the Dutch Edusite (www.edusite.nl), the SURF foundation (www.surffoundation.nl), and several TOC alerts from digital libraries such as EdITlib (www.editlib.org), ICT in Education E-zines, Innovation Management, and Business and Management Publications. During the investigation several sideways and crossroads with other scientific domains were explored for instance the catalogue of the university's library to look up references. Sometimes the treasury of the university's library was visited to find original editions of the works of famous philosophers. Holding and smelling such first edition publications from Descartes, Newton, Darwin, Kant, Hegel, Nietzsche, and others really was an sensational and enriching voyage: however, we visited the online 'Gutenberg Project' (www.gutenberg.org) for English and copyright-free versions to take original quotes.
The catalogue of the public's library was also used on a regular basis, colleagues were periodically interviewed about their latest opinions, book shops were scoured, and many times Google and Wikipedia were browsed to look up additional information, references, background material, opinions, look at state-of-the-art technologies from companies and reviews from innovators and from early adopters.

1.6.2 Case Study and Quantitative Approach

Case study research is used to examine a contemporary phenomenon in its natural setting and real-life context (Hamel et al., 1993; Stake, 1995; Tellis, 1997; Yin, 1994, 2002). Case studies can be single or multiple. We opted for a quantitative approach because of the millions of logged data handlings per case or dataset, related to the VLE's applications, and because using multiple cases support robustness and allowed us to validate our investigation. To work on multiple cases we had to determine what data we would focus on considering the 'equivalence' and 'independence', thus we first conducted an explorative case study for an in-depth investigation of the empirical data. Equivalence takes care that similar data are collected from multiple cases and independence asks for a widespread sample of datasets, which is important for generalisation (Goedegebuure & Vught, 1994). Multiple cases were used to replicate pattern matching, and thus for increasing the robustness and validity of the study.

We chose the dominant Blackboard VLE as the fixed variable because we were exploring to find patterns for growth, diffusion, and users' uses. For this reason, we have excluded other VLE systems such as ClassCampus, COSE, FirstClass, LearningSpace, Teletop, TopClass, WebCT, and so on (Inspiral, 1994). As our explorative case study we investiged the VLE of the Delft University of Technology because of our affiliation with the institute and for proximity reasons with respect to the system's owner, the system's administrator, and the VLE system itself. We focused on both the uses of the VLE's functionalities and on the VLE system. The uses of the functionalities was investigated for the teacher and student, while investigation of the uses of the system was focussed on its growth and diffusion.

After determination of the logged data that refer to the VLE's applications we composed collection queries and sent them to other institutions to acquire similar datasets from their databases. We collected a vast number of datasets to strive for robust conclusions. We formulated two hypotheses to test the findings of the VLE's growth and its uses with standing innovation theories.

1.6.3 Future Methodology

Future methodologies give guidance for formulating possible future educational practices based on upcoming technologies. The purpose of future methodologies is to explore systematically, create and test possible and desirable future visions. Future visions can help to generate long-term policies, strategies and plans, which can help to bring desired and likely future circumstances into closer alignment (Glenn & Gordon, 1994).

We followed the ideas of the 'Futures Wheel' (Glenn, 1994a), which is a simple method for identifying and packaging primary, secondary, and sometimes tertiary consequences of trends and events within concentric circles. The Futures Wheel is used by corporate planners and public policymakers to identify potential problems and opportunities, new markets, products, and services and to assess alternative tactics and strategies. We elaborated on the outcomes of research sub questions A and B to derive future educational technology from information technologies which already are in use within the corporate sector. The future educational technologies might enforce an imaginarily educational practice. Such combination of upcoming technologies, possible accompanying educational practices and influencial developments were set out in a Futures Wheel position to answer research sub question C. The outcomes of research sub question C were the focus for the strategy for shaping the next generation university. In our epilogue we defined several key principles which fit with possible future educational practice and its educational technology.

1.7 Dissertation Outline

We set the course for our study in Chapter 1, aiming at the university's position, which is under pressure due to financial matters, increasing student populations, need for life-long-learning, upcoming and fast changing technologies and new educational practices. We defined the problem statement and posed three research questions.

The theoretical framework in Chapter 2 discusses the referred theories and the two hypotheses of the second research question.

Chapter 3 provides an extensive overview of major developments concerning the universities over the ages. Several societal, technological and economic changes are discussed. The chapter also holds a philosophical reflection with propositions. Research sub question A is answered in Chapter 3.

The data collection procedure to obtain the empirical data with the help of an explorative case investigation into the Blackboard VLE is described in Chapter 4. Blackboard's logging data is explored and a procedure worked out to collect the vast amount of research data subsets.

The collected data subsets are analysed in Chapter 5. Descriptive and testing analyses are worked out to describe the uses, growth, and diffusion of the Blackboard virtual learning environments. Research sub question B is discussed and answered in Chapters 4 and 5.

In Chapter 6 the empirical findings are confronted with outcomes from literature.

Based on outcomes from chapter 3, 4, 5, and 6, and on existing and upcoming technologies a possible educational practice for the near future is synthesised in Chapter 7. Research sub question C is answered.

In Chapter 8, the epilogue, seven key principles are formulated for the facilitating university as a possible next generation university, which are based on literature only.

2 THEORETICAL FRAMEWORK

The Book was proving far more stubborn than Artemis Fowl had anticipated. It seemed to be almost actively resisting him. … Once the Book was translated, Artemis could begin planning in earnest. He already knew what the ultimate goal was now he could figure out how to achieve it

From Artemis Fowl
by Eoin Colfer (Colfer, 2001)

A theoretical framework is used to set the guidelines and boundaries for research activities. The works and theories of several researchers are described in this chapter to gain an outline for our study. We will look at organisations and systems with higher education and educational technology as the focal point.

2.1 EDUCATIONAL CHANGE STUDIES

Many education researchers have investigated change within the educational field and extensive research has been done on education change and implementation strategies within the education domain. According to Adrianna Kezar, in her critical synthesis about change literature, the focus is cultural, social-cognition and political models. Six main categories of 'theories of change' can be discerned to help us understand, describe and develop insights into change processes (Kezar, 2001).

1. Evolutionary theories: these assume that change is a response to external circumstances, institutional variables and the faced environment. Social systems evolve naturally over time because of external demands (Morgan, 1986).
2. Teleological theories or planned change models: these assume that organisations are purposeful and adaptive. Change occurs because leaders, change agents and others see the necessity for change (Camall, 1995; Carr & Hard, 1996).
3. Life-cycle models: these evolved from studies of child development and focus on stages of growth, organisational maturity, and organisational decline. Change is conceptualised as a natural part of human or organisational development (Levy & Merry, 1986).
4. Dialectical models or political models: these characterise change as the result of ideology or belief where conflict is seen as natural human interaction (Bolman & Deal, 1991; Morgan, 1986).
5. Socio-cognition models: these describe change as tied to learning and mental processes, such as sense making and mental models, where individuals see a need to learn, grow and change their behaviour.
6. Cultural models: these assume that change occurs naturally as a response to alterations in the human environment though the process seems to be slow and long term (Morgan, 1986; Schein, 1985).
7. Kezar emphasises unique characteristics of higher education institutions that need to be taken into account when considering change, such as interdependent organisation, relatively independent of the environment, unique culture of academy, institutional status, values-driven, multiple powers, authority structures, loosely coupled systems, organised anarchical decision-making, professional and administrative values, shared governance, employee commitment and tenure, goal ambiguity, image and success (Kezar, 2001).

We used an eclectic mix of the mentioned approaches for our study. We used an evolutionary approach because the Blackboard corporation added new features asked by clients who used the system in their institute, for instance social software elements that users demand from education; in other words the environment is changing and higher education has to survive by adapting. The teleological approach was chosen because higher education should adapt by purpose; the life-cycle approach was chosen because of the product and economic life-cycles of educational technologies. A dialectical approach was chosen because the adaptation of higher education has to deal with on-going discussions in politics, higher education, business and market. Socio-cognition is important when we consider the discussion of standing and emerging learning theories and paradigms, and a cultural approach is necessary because we focussed on Western universities since the start of higher education.

James Ellsworth studied the field of educational change models and he placed them in multiple, categorised but connected, angles or views calling it the '360 degrees view of educational change processes '(Ellsworth, 2000). He collected different major perspectives which he calls 'models of change' and combined them into a toolbox for the practitioner to manage the complete change process within education. Where Kezar discerns main categories of change Ellsworth presents successive steps of change. The toolbox is a guideline of how to proceed through the change process and the several steps to change are described from start to end.

Although most of the toolbox components come from education researchers the first is taken from Everett Rogers' model of the diffusion of innovations within several disciplines of the corporate sector (Rogers, 2003). The other 'models of change' are the educational environment with its conditions of change (Ely, 1990), the change agent for the meaning of educational change (Fullan, 1999), the educational change process with the change agents guide (Havelock & Zlotolow, 1995), the intended educational adopter using the Concern Based Adoption Model (CBAM) (Hall & Hord, 1987), education resistances in strategies for planned change (Zaltman & Duncan, 1977), and the systems thinking approach for a systemic change in education (Reigeluth & Garfinkle, 1994).

Michael Fullan, a world renown education researcher, claims that the careful study of educational change only began in the 1960s (Fullan, 1999). He has been writing about the subject since the 1970s, and has distinguished three main phases in the evolution of educational technology, which he labels 'adoption or initiation or mobilisation', 'implementation failure or implementation success', and 'intensification versus restructuring', which can be called 'institutionalisation'. Fullan presents a model with the three broad interactive phases that can be used to indicate the change process, this is placed in a timeframe from adoption to institutionalisation. Moderately complex changes in education take from three to five years, while major restructuring efforts can take five to ten years or even more (Fullan, 1999). It is our aim to build an implementation timeframe for the VLE as one of the technologies that have been introduced within higher education since the 1960s.
The implementation of new educational practices are affected by the 'characteristics of change', which are 'need', 'clarity', 'complexity', and 'practicality', they are affected by the 'local characteristics', which are 'district', 'community', 'principal', 'teacher', and they are affected by the 'external factors', which are 'government' and 'other agencies'. Fullan argues that the persons involved are stakeholders (Gayle et al., 2003) who all have their responsibility and interaction. It is the meaning making of the educational change process which should be consistent for the different individuals in the different roles. The challenge is to begin, to reach out, to establish areas of common interest and to move forward (Ellsworth, 2000; Fullan, 1999; Fullan & Hargreaves, 1991). We have kept the stakeholder concept in mind when we designed a possible future educational practice.

Betty Collis, a Dutch pioneer in online learning, corroborates the argument that there seems to be a general agreement that higher education must change and that information and communication technologies (ICT) will be involved in this change. She argues that change as such is inevitable within education and for this reason the 'why' is not so important as the 'how' question (Collis & Moonen, 2002). Educational technology is often discussed as an inevitable companion of change in higher education. Collis's different phases of ICT implementation and instructional change are 'tolerating the pioneer', 'letting a 1.000 blossoms bloom' and 'adopting a strategy for managing change'. She developed the 4E (environment, effectiveness, ease of use and engagement) model for practitioners that predicts the likelihood that an individual instructor will adopt an innovative technology into his or her daily practice (Collis, 1997; Collis & Moonen, 2002; Collis & Pals, 2000). Colllis has conducted a fine study where some sort of repetition was found for the PC in the 1980s and the web in the 2000s, see Section 3.4.3. We focussed on such repetitive but successive technologies in order to meet Kezar's evolutionary approach.

Paul Goodman provides a three step change process of 'planning', 'implementation', and 'institutionalisation' (Goodman, 2002a). Goodman uses socio-technical analysis and argues that it is better to change both the technical and social aspects of an organisation simultaneously rather than to focus on any one system. The human, organisational and technological systems must be aligned to achieve effective change. Within the implementation phase the motivation commitment, unfreezing and moving to a new state; socialisation; feedback and redesign are important issues. The institutionalisation phase refers to a process where the change persists over time and the new learning environment becomes a part of the structure, norms and values of the organisation (Goodman, 2002a). Two dilemmas of change in universities are (Goodman, 2002a, 2002b):

1. the time lag between initiating an organisational intervention and experiencing the benefits
2. the diversity of the educational units, which makes it difficult to diffuse change through out an organisation

We focussed on both the technical and the social aspects in our challenge to describe the next generation higher education.

Gene Hall and Shirley Hord have designed a comprehensive framework of change in educational institutions called the concerns-based adoption model (CBAM) (Hall & Hord, 1987). The model has been used and validated by many educationalists. Hall and Hord argue that the implementation of change in schools is driven by a 'change facilitator team' which probes and diagnoses within the user system, and intervenes by cultivating and promoting the objectives of the innovation within the user system. Hall and Hord introduce three tools and techniques for change facilitators, which are listed below.

1. 'innovation configuration map': this is used to follow the state of the innovation during the process to promote a common understanding on the main characteristics.
2. 'stages of concern' (SoC): this is used to determine the affective dimension of the change process and it distinguishes 7 levels of concern: 'awareness, little concern'; 'informational, information collection'; 'personal, what is in it for me'; 'management, how to deal with the innovation'; 'consequence, attention on impact and its consequences'; 'collaboration, exchange with others' and 'refocusing, exploration of benefits and alternatives'.
3. 'levels of use' (LoU): this is used to distinguish 8 levels of use: 'nonuse', 'orientation', 'preparation', 'mechanic use', 'routine', 'refinement', 'integration' and 'renewal'.

Both the SoC and LoU are descriptive and diagnostic models that can be used to find the rational use of interventions. The facilitator team, initiator, manager, and, or responder, follows the assumption that organisations do not change until individuals within it change. In this context, interventions may provide support for learning at different levels of the organisation, but they can only be successful if the people and teams agree (Hall & Hord, 1987). We kept the Concerns Based Adoption Model in mind to define our key principles of research sub question D.

Concluding Remarks for Educational Change Studies

In the last 4 decades a multitude of research has been conducted within the field of educational change. Such change research has kept pace with the developments of educational technology, however, technology has not been seen as a change instigator or push factor. It is striking that education researchers are confident that educational technology is a catalyst for reforming educational practices but educational technology as such has not been considered the instigator for change processes nor have technological models been applied to support such change processes (Collis et al., 2002; Dexter et al., 1999; Kezar, 2001). Several researchers argue that such changes are forthcoming, drawn from managerial, organisational, or socio-political influences, however, the technology is considered to be the inherent tool to support change processes in education. It is only recently, that educational researchers have started to argue that educational technology is becoming a more important change factor, one that does more than support the process. The technology is changing the ways we work and communicate, and the ways in which we deal, select, process and share information (Oblinger & Oblinger, 2005; Pedro, 2006; Veen & Vrakking, 2006).

Kezar found that life-cycle models have not, for the most part, been applied to higher education institutions (Kezar, 2001), but one can argue that the students of today have grown up with technology to hand, for them the use of information technology tools is intuitive in many cases and thus obviously present. Hence, educational technology has started to dominate change processes.

a. ***We wondered if educational technology, as instigator instead of only being considered as a catalyst, can lead us to future educational practices.***

2.2 SIGMOID CURVE FOR INDICATION OF GROWTH

Sigmoid-curves, growth curves or logistic curves are commonly used within a variety of disciplines. They are used to indicate lifecycles of organisms, of products, of businesses and of logistics. Benjamin Gompertz was probably the first person who applied the exponential function for practical applications. He first applied such curves, now known as the Gompertz growth curve for the calculation of mortality rates, this is also known as the 'law of mortality' (Gompertz, 1825). The mathematician Pierre Francois Verhulst proposed using logistic growth for modelling population growths (Verhulst, 1845) and the biologist Ludwig von Bertalanffy derived functions for individual growth model (Bertalanffy, 1934). In general the S-shaped curve is produced by the mathematical function $P(t) = (1 + e^{-t})^{-1}$ and represents a curve with an S-shape; it is non-linear and exponential. Many sorts of derivative and or additional formulas are used for different purposes to obtain better results dependent on the objective. The exponential attribute is important because it suggests that the curve is driven by a factor which represents the 'rate of change'.

Richard Foster is considered to be the first person to propose using the S-shaped curve for anticipating technological progress (Foster, 1987). He argued that when investments were made to develop a new product or process, the product or process began slowly, once essential knowledge was gained to boost the product or process growth would increase exponentialy, until the product reached its boundaries and growth stopped.
In the corporate world sometimes the end of a product is announced by management or corporate stakeholders (Christensen, 1997; Foster, 1987; Foster & Kaplan, 2001). A product's life cycle may not be over but the financial income, the 'cash cow', has stopped growing. Such decisions lead to severe measures: a period of unlearning the product begins, which is very difficult. Sometimes the experts on the older technology are dismissed, former friends or colleagues object to this, unions may be brought in, often the whole business model is changed. This is a very painful operation for those involved and means change to the fullest extent. While the mature S-curve of the older product decays another S-curve will begin to develop for a new product if one is set in place (Foster, 1987; Foster & Kaplan, 2001). Dependent on the technology, it is also possible that a physical limit will be reached at the end of the curve, such as reaching maximum pressure when inflating a tire, the maximum weight a carrier can hold, the maximum of miniaturised transistors on a chip. Gaining insight into growth patterns of educational technology may bring us the opportunity to estimate the lifespan of educational practices based on the technology applied.

Frank Bass pioneered the development of the modern business school and was one of the founders of the field of marketing science. Bass started to apply a mathematical model using different equations for marketing and management purposes. The famous Bass model shows growth and diffusion patterns for all sorts of domains and is widely used in product and technology forecasting (Bass, 2004; Mahajan et al., 1995). The forecasting part seems very promising and therefore we decided to use it for educational technology.

Rias van Wyk addresses the evolution of technology in his strategic technology analysis (STA), which is an approach to evaluate technologies on the basis of their intrinsic characteristics. Within STA technology is defined as competencies, created by people, and expressed in devices, procedures and human skills. Van Wyk discusses graphing technological trends as a well researched area and distinguishes 'curves of technological parameters', 'size curves', 'cost curves' and 'substitution or diffusion curves'. Van Wyk also makes extensive use of the S-shaped curve. Particular configurations of, for instance, developments of multiple materials in time may be depicted as a series of S-curves reflecting successive generations of such technology (Wyk, 2004). We used the idea of successive generations to present several generations of educational technologies.

Today the technology S-shaped curve is often used by company strategists as it is based on a fairly straightforward concept (Lemstra, 2006). It tracks the progress of a base technology as a function of R&D effort or in time. The start of the S-curve is called the 'point of rupture' (Crowley, 2003). Incremental innovations cause a continuation and upswing of the curve following exponential growth and on the mature side of the S-curve the growth diminishes. Somewhere around the middle of the S-curve is the inflection point, where growth starts decreasing while still clearly present (Carayannis & Wetter, 2004; Crowley, 2003; Wunderlich & Khalil, 2004).

b. ***We wondered if the S-shaped curve, as product forecasting approach, can be used to catch the growth of educational technology in operation.***

2.3 ADAPTIVE STRUCTURATION THEORY

Gerardine DeSantis and Marshall Scott Poole are originators of the Adaptive Structuration Theory (AST). The theory is an approach for studying the role of advanced information technologies in organisation change. The change process is examined from two perspectives namely 1) the types of structures provided by the advanced technologies and 2) the structures that emerge through human action as people interact with these technologies (DeSanctis & Poole, 1994).

The work of DeSanctis and Poole is based on the 'Structuration Theory' of sociologist Anthony Giddens, who believes that society only has form, and that it is such form only that has an effect on the people, in so far that the structure is produced and reproduced in what related people do. Such social structures are built upon traditions, institutions, moral codes and established ways of doing things, and they can be changed when people start to ignore them, or replace them, or reproduce them differently (Giddens, 1984).

DeSanctis & Poole have been taken Giddens' theory to study the interaction of organisations with information technology. Their theory criticises the idea of 'technology push' as a single sided force and emphasises technology's uses and socially related aspects. They argue that the use of such technology creates its own social behaviour within organisations through its uses. Systems and structures exist in a dual relationship such that they tend to produce and reproduce in an ongoing cycle. This is referred to as the *'structuration process'* (DeSanctis & Poole, 1994). It is useful to consider groups and organisations from a structuration perspective because it helps to reveal a possible pattern in the choices of groups of people, and it makes clearer the evolutionary character of groups and organisations, moreover, it suggests possibilities how members of groups may be able to influence their behaviour of uses.

People will slowly adopt technology when applying it. Initially some easy functionalities of the technology will be mastered. Later, when such mastered functionalities become automatic behaviour, the less-easy functionalities will be mastered up to a level that fulfils the needs of the person to meet daily work actions. In other words, people and organisations use information technology for their work to create dynamically perceptions about the role and utility of such technology, and how it can be applied to their own activities. This process is called *'appropriation'* (DeSanctis & Poole, 1994). To appropriate an object means to use it constructively, to incorporate it into one's life, for better or for worse (Ollman, 1998).

Adaptive Structuration Theory may be used to analyse various innovations such as the printed press, electricity, radio, telephone, television, computer, internet, office environments and it can also be used to analyse the VLE. The theory allows us to determine how the structures of innovations penetrate societies, influence them, and how social structures of these societies in turn influence and modify the innovations' original intent (DeSanctis & Poole, 1994). In conclusion, AST's appropriation process was seen as a good model to analyse the utilisation and penetration of educational technologies within the educational settings. It is a theory that puts human behaviour in the context of technology and focuses on iterative modifications of reactions and adaptation to the information technologies.

c. ***We wondered if educational technology in operation can show us appropriation and structuration processes.***

2.4 DIFFUSION AND INNOVATION THEORIES

Longstanding research activities have been conducted into the field of diffusion. Diffusion is the process by which an innovation is communicated, or rather disseminated, through certain channels over time among the members of a social system (Rogers, 2003). Everett Rogers, globally known for his work, began integrating diffusion patterns from all sorts of disciplines in his model.

In the domain of information technologies Richard Nolan has investigated the way in which computer technology is applied within corporations. Nolan studied the dimensions ‘uses’, ‘finance’ and ‘management’ to follow the implementation and growth of computer technologies within a company. Berkhout’s Cyclic Innovation Model is a recent theory that gives a comprehensive framework for innovations in general. The diffusion, growth and innovation theories are presented briefly in this section.

2.4.1 Rogers’ Model for Diffusion of Innovations

Many investigations into the diffusion of innovations have shown that there are standard patterns that occur when innovations take place, whether it concerns rural innovations, technological, organisational, or educational innovations. Everett Rogers has conducted research in the field of diffusion for nearly five decades (Rogers, 2003). His book about the diffusion of innovations has reached its 5th edition since 1962. According to Rogers the innovation-decision process is essentially an information-seeking activity in which an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. One of the most distinctive problems in the diffusion of innovations is that the participants are usually heterogeneous. In general, an innovation can be adopted or rejected, but once a *critical mass* has been reached, the adoption of an innovation follows an normal bell-shaped curve as depicted in Figure 2 (Rogers, 2003). The literature does not reveal a determined value or defined level for critical mass, only a vague concept (Ball, 2004; Rogers, 2003). In general, critical mass is a sociodynamic term used to describe the existence of sufficient momentum in a social system such that the momentum becomes self-sustaining and fuels further growth (Wikipedia, 2008). According to Rogers the critical mass should be somewhere between 10 and 30 percent. When the cumulative number of adopters is plotted, the result is an S-shaped curve.

d. We wondered if the critical mass can be caught for the implementation of VLEs.

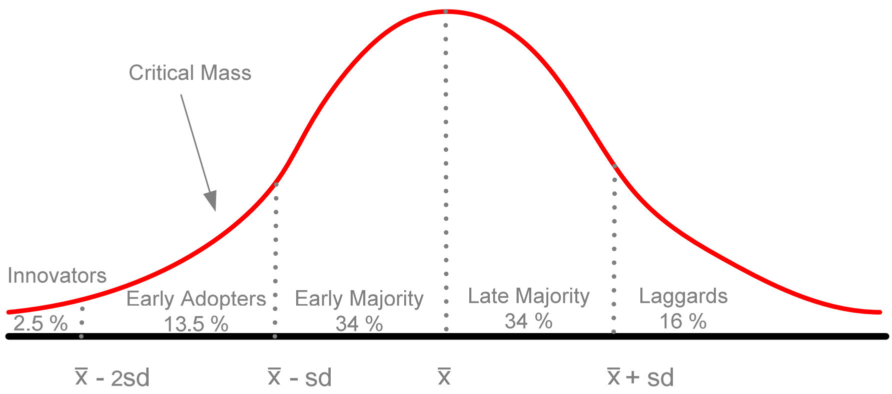


Figure 2: Adopter Categorisation versus Innovativeness by E.M. Rogers (2003)

The innovativeness dimension, as measured by the time at which an individual adopts an innovation, is continuous. The variable of innovativeness is partitioned into five adopter categories by putting off standard deviations (sd) from the average time of adoption (x). The five adopter categories are ideal types, concepts based on observations of reality that are designed to make comparisons possible. The five adopter categories are (Rogers, 2003):

- *innovators*: (venturesome). Venturesomeness is almost an obsession with innovators. Their interest in new ideas leads them out of a local circle of peer networks and into more cosmopolite social relationships.
- *early adopters* (respect) are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localites. This adopter category, more than any other, has the highest degree of opinion leadership in most systems. Potential adopters look to early adopters for advice and information about an innovation.
- *the early majority* (deliberate) adopts new ideas before the average member of a system. The early majority interacts frequently with their peers but seldom hold positions of opinion leadership in a system.
- *the late majority* (sceptical) adopts new ideas just after the average member of a system. Adoption may be both an economic necessity for the late majority and the result of increasing peer pressures.
- *laggards* (traditional) are the last in a social system to adopt an innovation. They possess almost no opinion leadership. Laggards are the most localite of all adopter categories in their outlook. Many are near isolates in the social networks of their system. The point of reference for the laggard is the past.

Concluding Remarks for Diffusion

Rogers' diffusion of innovations curve is really useful when one tries to convince a whole organisation to make a quick turn based on, for instance, new technology. It is advisable to approach the innovators and early adopters first to come to a critical mass from where new policy-making can start to trigger the remaining people in the organisation. When an organisation chooses a strategy where its whole population must be ready to make a turn or change then a lot of energy may be lost in addition to the inherent delay often found in such moves. Sometimes such a delay is welcome and fits a chosen policy, but more often it will lead to an unwelcome strategic backlog. In our study we searched for diffusion patterns based on the adopter categories of Rogers.

e. We wondered if the VLE's diffusion can be caught in Rogers's adopter categories.

2.4.2 Nolan's Growth Model for Organisational Learning

Extensive research has been carried out by Nolan and others on IT and ICT uses in the corporate sector ever since the electronic data processing (EDP) era in 1960 (Khandelwal & Ferguson, 1999; Kurzweil, 1999; Mutsaers et al., 1998; Nolan, 2000; Nolan & Croson, 1995; Nolan et al., 1992; Nolan & Gibson, 1974; Zee & Koot, 1989). According to Nolan and others every IT application used for the automation of business processes has grown along the path of a natural S-shaped curve, as depicted in Figure 3.

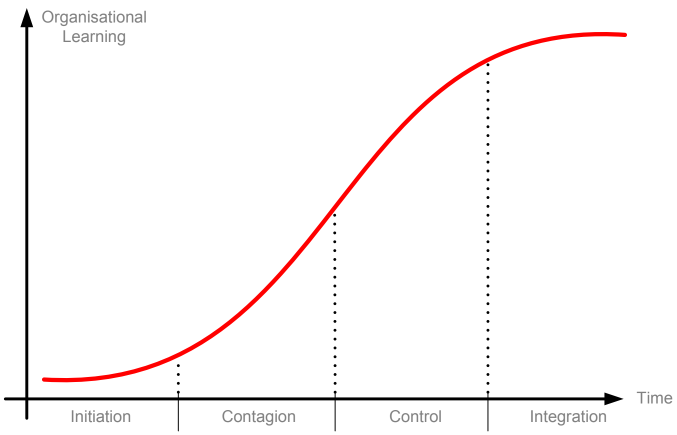


Figure 3: Four Stages of an S-shaped Curve according to Richard L. Nolan (1974)

According to Nolan the S-shaped curve consists of four distinct stages of growth from scratch to maturity (Nolan & Gibson, 1974). The first flat stage stands for a small increase in growth and is called 'initiation', which represents experiments, automation of simple and isolated tasks and limited investment. The second steep part, where growth is increasing rapidly, stands for 'contagion', for the spread of success, rapid expansion and little control. The third stage stands for gaining 'control' on the expansion and corresponding costs, coupled with policy making. Growth in this third part will begin to decrease and finally the fourth stage where growth has stopped, or almost so, this is 'integration' or mainstream, for complete implementation and exploitation. Carlota Perez combines the Sigmoid curve with financial developments and calls the four stages respectively 'irruption', 'frenzy', 'synergy' and 'maturity' (Perez, 2002).

Nolan argues that once a matured automated process has been integrated in the organisation and is considered to be a normal procedure, i.e. mainstream, successive processes will become eligible for automation. Such successive processes also follow the shape of an S-curve, see also Foster (Foster, 1987; Foster & Kaplan, 2001). The changeover or transition between the former and latter S-curve is not so easy, and certainly not self-organising. An organisation must carefully plan and facilitate such transitions, this can lead to enormous thresholds due to technological discontinuities. Switching from technologies is representing change to the fullest (Eijnatten, 2003; Nolan, 2000; Zanden & Veen, 2003a, 2003b).

The successive S-curves overlap during a period of 'technological discontinuity'. During this period further growth of mature old technology directly conflicts with the vigorous growth of emerging new technology. Management and IT workers who have mastered the old dominant design will struggle to retain their knowledge power in an organisation against those who propose its replacement with a new technology. This struggle is a familiar one in history and one where, with few exceptions, the new technology has won. Ironically, those who win the struggle in one round will, almost certainly, lose it in the next (Nolan & Croson, 1995).

The three eras, which Nolan describes as the S-shaped organisational learning curves, in which three dominant designs of IT are being assimilated into organisations are illustrated in Figure 4 (Nolan, 2000; Nolan & Croson, 1995). The Figure shows the data processing (DP) era dated from 1960 to 1980; the microcomputer (micro) era dated from 1980 to 1995; and the network era, which began around 1995, is expected to continue until 2010.

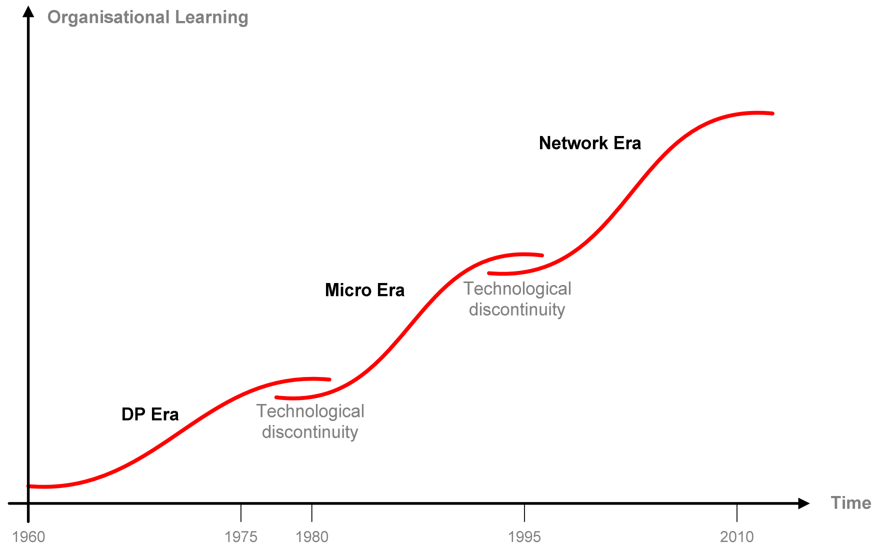


Figure 4: Three eras of Information Technology to support Organisational Learning (Nolan, 2000)

The technological discontinuities shown in Figure 4 indicate that new technologies have been brought into the organisation. The organisation has to switch from older technology to newer technology to modernise the work environment and to develop organisational learning further. Once newer technology is accepted then new jobs occur and the organisation will demand new types of advice, ways of working and support. This can lead to a lack of qualified staff and vacancies. staff related to older technology can be retrained when possible, but others will be dismissed or made redundant. Such radical switchovers or reorganisations can be really painful operations and mean 'change' to the fullest, unlike the small steps of 'progress' which grow along the S-curve.

Concluding Remarks for Growth

According to Nolan history shows that each industry, and each organisation within an industry, will experience a few years of lead or lag in their learning of associated technologies. Senior level management and IT management in an organisation within an industry directly influence the pace of change and technology adoption. This is intriguing because it gives an organisation the opportunity to manipulate its growth patterns and growth speed, to move to a strategic front position. In other words 'rate-of-change' is influenced by an institution's policy. In our study we searched for growth patterns based on the growth scenario of Nolan.

f. ***We wondered if the VLE's growth can be caught in rate-of-change and lifespan parameters.***

2.4.3 Berkhout's Cyclic Innovation Model

Berkhout's Cyclic Innovation Model (CIM) gives a comprehensive approach to technological innovations in which multiple domains are intelligently positioned, CIM is an instrument which connects the continuous development of four domains *scientific exploration*, *technological research*, *product development*, and *market transitions*. A fundamental characteristic of the CIM model is that it represents *cycles of development* in stead of for instance value chains (Porter, 1985, 1998) with a beginning and an end (Berkhout, 2005). The innovation within one of the cycles can start anywhere within the loop and such innovation grows gradually to a higher state of innovation. The four domains of scientific exploration, technological research, product development and market transitions, are represented in Figure 5 with *nodes of change*. The nodes of change are interconnected with the *cycles of change*, which stand for the continuous cyclic interactions between the nodes. The cycles of change are *technological oriented science* cycle, *systems engineering* cycle, *customised service* cycle and *society oriented science* cycle.

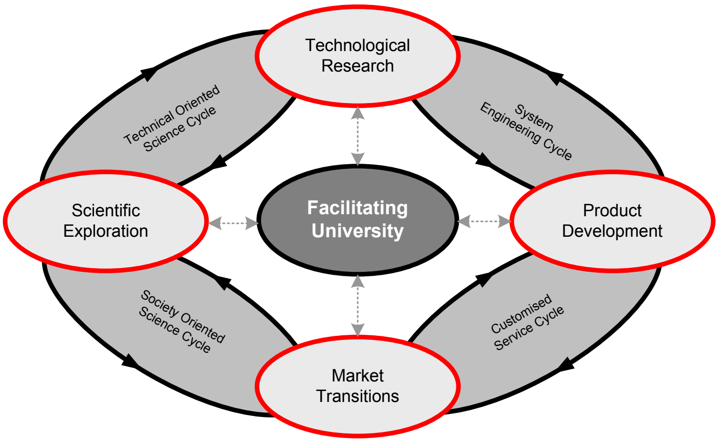


Figure 5: Berkhout's Cyclic Innovation Model (2005)

The arena of circles indicate ever continuing developments or progress within a certain area, the upgrade of value chains would cause a more radical change within an area in which they operate. The CIM model allows us to classify multiple *levels of change*, for instance innovations based on changes within a certain node are called class-1 innovation change, when two nodes are involved we may speak of a class-2 innovation change up to a maximum of class-4 innovation changes, which are radical and dramatical (Berkhout & Duin, 2007; Berkhout, 2005; Cambridge University Press, 2001). Class-1 innovation changes are comparable to what we call progress, while the class-2, class-3 and class-4 changes will have increasingly radical characteristics.

Concluding Remarks for Cyclic Innovation Model

The CIM model is a supportive model for entrepreneurship, it connects science (left half) with business (right half), and technology (upper half) with markets (lower half). Entrepreneurship requires an innovation arena, such as a science institute bonded to a neighbouring science park where young and innovative entrepreneurs work enthousiastly.

g. ***We wondered how the CIM model can be applied within higher education to prosper an entrepreneurial state of mind.***

2.5 RESEARCH APPROACH

We wanted to make use of the corporate innovation and diffusion theories for our study. We wondered if the forecasting lifecycles of innovations and products also count for a virtual learning environment, and because educational technologies are used within both the corporate and education sectors we wondered if there was a relationship between the growth and use of ICT within corporations and the growth and use of educational technology within universities. Corporations and education institutions fight different challenges on their way to prosperity: corporations modernise their processes and systems to cut costs and gain efficiency, where education strives to optimalise teaching and learning with knowledge transfer as its main purpose. We believe that it is the boost for economic prosperity and market push which forces education to modernise its ways of knowledge transfer, hence we wanted to see if corporate innovation theories could be applied to the education sector. We wanted to provide scientific evidence for such hypothesis and therefore we confronted our research findings in Chapter 6 with the theories discussed in Section 2.4.

We also wondered if the uses of VLE's applications follows the adaptive structuration theory discussed in Section 2.3: Do users of VLEs change their uses over time? Do users change their order or type of VLE applications and is there a pattern to reveal? We wondered if such ordered steps exist and if they do: Do they also follow an S-shaped curve? We wondered if VLE applications follow the minor and successive S-shaped curves that can be found within a larger system's S-shaped curve.

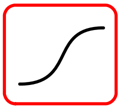
Our approach is supported by the 'a priori' and 'a posteriori' approaches as Immanuel Kant has been calling them (Kant, 1787). An 'a priori' approach is reasoning without the support of observation or in our case, without empirical VLE data. Based on the literature we constructed an image of the shaping process of today's higher education. Using the educational technology of today, in our case, a virtual learning environment, we were able to elaborate into the future using a robust point in time as a start point. This allowed us to integrate the 'a posteriori' approach. Using our empirical data we attempted to provide evidence that a VLE's educational technology matches the theories of innovation, diffusion and adaptive structuration. The Futures Wheel method was used to support the elaboration (see Section 1.6.3).

To determine a robust point in time the Blackboard VLE was taken and scrutinised for its uses using its system logs. We focussed on the user's uses, or the small picture, and on the VLE system's growth, or the big picture. We had to find a way to connect the high level of the system's features, big picture, with the low level uses of teacher and student, small picture. We made use of inductive, deductive and abductive reasoning to find this connection.
Inductive reasoning is looking for generic rules or patterns based on empirical observations, for example: two nights ago no worker was online in the VLE, the night before yesterday no one was online, and last night there was also no one was online. The generic rule might be that no one works at night.
Deductive reasoning is based on reasoning from fact to conclusion, or from cause to effect, where generic rules guide the reasoning, for example: students work online with the VLE, the generic rule is that everyone communicates, and the consequence might be that the students communicate online. The deductive researcher starts with a preliminary causal network and the inductive researcher ends with one (Miles & Huberman, 1994).
Abductive reasoning follows the path from effect to cause, for abduction one has to be more creative, and inherently, one can find multiple possible causes for a certain effect (Lubbe & Zoest, 1997a; Nauta, 1997). For example: no one is online at night where the generic rule might be that the office hours are during the day. The conclusion might be that the VLE is shut down outside office hours, or no one feels obliged to work outside office hours, or there are no night shifts for staff, or the infrastructure provider blocks all communication at night, etcetera.

Such explanations are better called hypotheses, because abductive reasoning leads to multiple possible explanations. Hypotheses need to be validated. We followed this path to connect the big picture with the small picture of the VLE's educational technology. We posed two hypotheses to test the 'line of arguments' from our abductive reasoning and to answer research sub question B.

2.5.1 Hypothesis 1

If we consider the innovation theories from this chapter in an 'a priori' way we might assume that the development of educational technology such as the VLE follows an S-shaped curve in time. This leads to the first hypothesis:



Hypothesis 1:
Implementation of VLE educational technology will grow along an S-shaped curve in time

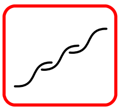
According to adaptive structuration theory the mastering of new technology grows through multiple small steps of improvement, this can be called progress as it is a continuous process of advance or increase: but do the smaller steps of improvement have a similar growth pattern to the S-shaped incremental innovations as Crowley argues (Crowley, 2003). When for instance an office automation environment is implemented: does this new environment represent the large S-curve and the mastering of its several functions and applications represent the smaller S-curves? Initially some tasks need to be learned before one can continue with the more dedicated process functions, for example, successive tasks or tasks which demand familiarity with cumulative knowledge drawn from earlier tasks. In this example the tasks may be called *'progress'* of the working behaviour while the new office environment may be called a complete *'change'* which often comes with the reorganisation of departments and or the reengineering of processes. Such is the distinction of progress versus change. We rather want to use the word *switch* to indicate such change of applied technologies. Another definition to describe the difference between smaller progress against the larger switch is Clayton Christensen's *sustaining* versus *disruptive* technologies (Christensen, 1997), he addresses the use of new technologies within business processes. The sustaining technologies build on standing business while disruptive technologies mean the end of a product line to start working on a completely new product (Foster & Kaplan, 2001).
Michael Fullan believed that confusion can be caused by the interchangeable use of the terms progress and change, his way of dealing with this confusion is to use of the word *meaning*. The problem of meaning is to understand the small picture for individuals at all levels of in the, in our case, educational system and the big picture deals with the socio-political process (Fullan, 1999). Although we agree with this distinction of small and big picture explanations we prefer to keep the terms progress and switch for the educational technology domain given the following definitions, which we have composed using the Cambridge Dictionary (Cambridge University Press, 2001) and insight from relevant literature.

- Progress is technology-induced growth of knowledge to an improved or more developed state due to the interplay between technology and the social processes of the technology's use (related to structuration and appropriation).
- Switch is the changeover to a new technology that disrupts a standing organisation, to modernise its working and learning environment and give way to further development of the organisation's knowledge.

If we follow the progress and switch definitions we can say that the larger S-curve resembles the VLE technology and the smaller S-curves resemble the VLE's functionalities.

2.5.2 Hypothesis 2

If the smaller S-curves are applicable for a VLE's functionalities then it would mean that the uses of the teachers and students must appear successively: Is this the case for the VLE?
Can we assume 'a priori' that the uses of the teacher and student of a VLE will follow the smaller and larger S-curve signatures? This leads us to the second hypothesis:



Hypothesis 2:
The uses of the VLE functionalities follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve

As the uses of a VLE are logged by a neutral system and the logged data are anonymous we cannot know why a user executed a certain action. Therefore we were unable to discuss a users' behaviour, we can only describe the uses and interpret the data in an abductive way. If we can validate the hypotheses then we can connect the small picture with the big picture. We realised that such abductive reasoning carries certain risks with respect of incompleteness of data, to minimise deviation and errors we aimed at a quantitative research approach using a multitude of cases.

2.6 Conceptual Framework

Any research design requires a researcher to take a number of carefully thought steps. How the steps for this research were designed is shown in the conceptual framework of Figure 6. A conceptual framework should show the relevant issues to be studied and the presumed relationships between them. Miles and Huberman state that conceptual frameworks are rudimentary or elaborate, theory-driven or commonsensical, descriptive or causal (Miles & Huberman, 1994). Our framework is based on Robert Yin's elaboration on case studies (Yin, 1994, 2002) because we first had to scrutinise the database of the DUT case Blackboard VLE to know which data records were related to educational applications. We could only design data collection queries after we had determined the education related calls to collect similar datasets from other institutions.

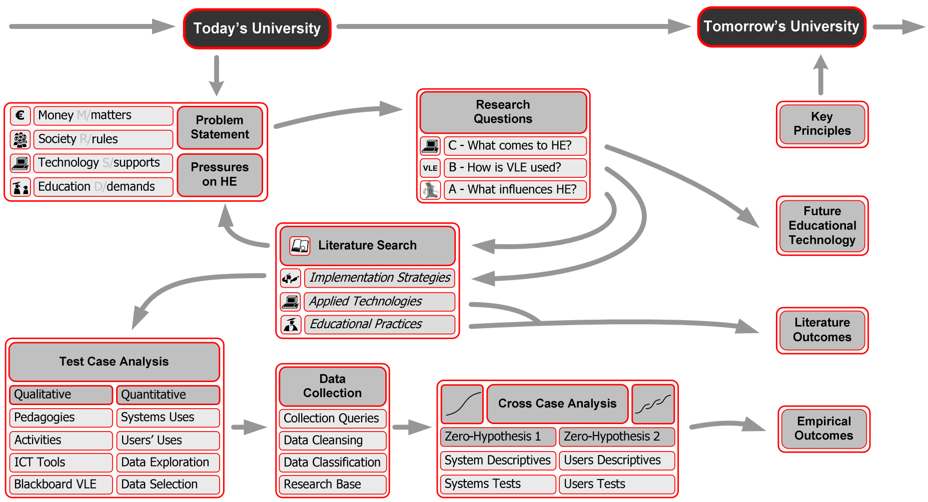


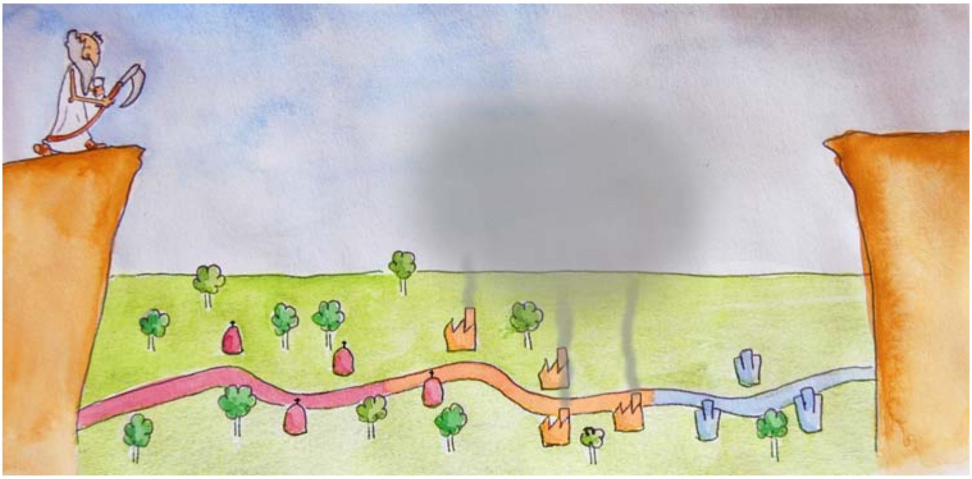
Figure 6: A Conceptual Framework explains the Main Artefacts to be studied.

The flow of our study is presented in Figure 6. Pressures on higher education led us to the problem statement of today's universities. We discerned three main streams from educational technology literature: *educational practices*, *applied technologies* and *implementation strategies*. Educational technology has been applied for more than 4 decades, hence, education has come to a state where the technology is used beyond support processes to transform educational practices. Transformation of education was the ground thought for our research questions. Successive literature searches were carried out to answer research sub question A, logging data were studied, with first an explorative case to design data collection queries, then an analysis of 289 collected datasets, followed by the confrontation of our empirical findings with literature to answer research sub question B, culminating in a graphical stage model of educational technology to answer research sub question C. Finally, we elaborated a future sketch for higher education that can be used to design key principles for educational managers.

FATHER TIME'S VOYAGE THROUGH THE AGES OF HIGHER EDUCATION

One day Father Time decided to go on a journey. He picked up his hourglass, packed it in a bag, took up his scythe and jumped down from his heavenly penthouse, landing in the Land of the Past in Chapter 3 - "Higher Education in Historical Perspectives".

He sees a deep gorge looming up before him, hesitantly he peers over the edge into the deep, and sees three successive colourful pathways, a beautiful purple one nearby, an orange path with a rather smoggy sky further on, and at the far end, a blue path with skyscrapers rising far above the horizon in a clean clear sky. The blue path leads to the Land called Future. Now it is time to switch paradigm, to take in the world from the ordinary man's view! What does he see?



Three impressive landscapes: the first, with the purple path looks like a holy land with cloisters and churches, with fantastic trees and green meadows, the second, orange one is dirty and smoggy, polluted with factories, and in the third, the Land of the Future, there are almost no trees. At least all the shiny windows and facades reflect the sun and spread a new light on the Future Land's environment, the air is clean.

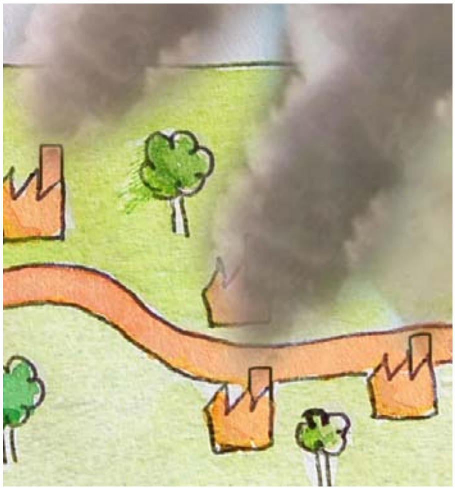
Father Time decides to walk on: How should he start? His only choice is the purple pathway made of beautiful, intricately patterned and coloured different shades of purple, cobble stones. Although the road seems incredibly old, the ancient cobble stones still carry an aura of wisdom. The road has something spiritual, something holy about it: "Was it a pilgrimage route once?", He asks himself.

As Father Time walks he comes upon brother Thomas Aquinas who is explaining to his listeners how flat the world is, and how Aristotle had it just right at his ancient Greek lykeum. He is choosing his words carefully and wisely. "Hmm, we know better now", Father Time reflects without saying the words.

Father Time walks on, he comes to a peaceful landscape with twittering birds. Farmers using rakes work in fields golden with wheat. Now, he walks on the pathway leading straight to the first generation university archetype. Look how fast technology has moved on. Already books, though few in number and hand-written, entitled 'tabula rasa', are used in the lecture. This is certainly Scholasticism, the apprentices are devote and silent.

Into the silence the bells of the cloisters and churches sound as they ring the hours. Father Time's ears hurt from all this noise. Still he is very relaxed when his path brings him to a wooden bridge. This bridge connects the purple cobbles to the orange brick road ahead. Suddenly another land is thrust upon him: the Land of Production. Alas, the 'green peace' and the serenity of the sound of bells dropped into stillness is no more.

Father Time walks on, along the path he meets brother William of Baskerville, he is copying a beautiful ornamented book that smells of incense and medicinal herbs. Father Time would like to talk to William but the *clanging and banging of nearby machines drowns out their words, the sounds of the Gutenberg machine in the nearby factory are painful to his ears.*



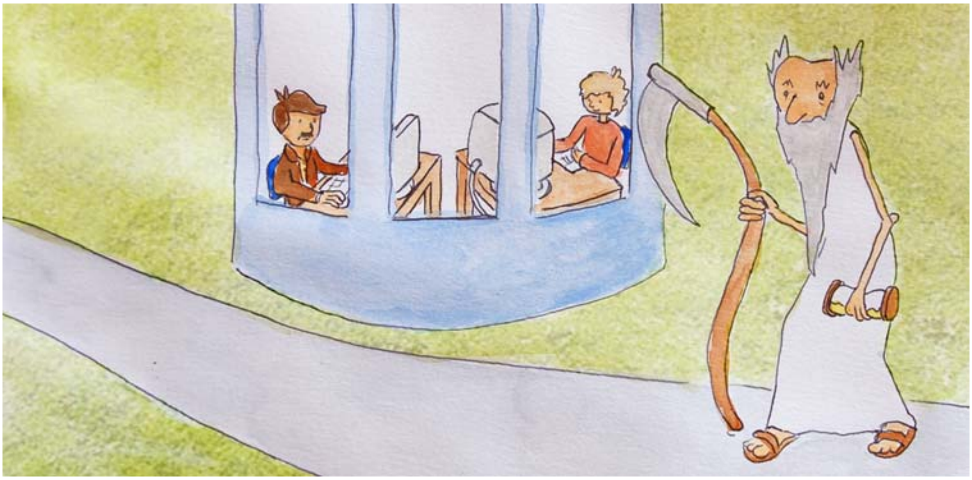
Father Time frowns as he walks on. Coming across even more machines, now driven by coal and steam, he frowns again and though the machines make loud noises still their movements are elegant and the shiny metals of the machines contrast with the thick smoke they exhale. How wonderful that such machines help man with their heavy labour, Father Time thinks, but how sad it is for man to be a machine's extension, working in dirty, unsafe conditions and for long hours.

Father Time walks on. Gradually smoke and steam turn the once beautiful blue sky into a sad yellow grey, the sounds of machines drown out the bird songs, stooped workers in blue overalls with grim faces run here and there in the factories, and the war machine steam rollers on flattening God's creatures on its way. "The creators of such machines have magnificent skills but where is our peaceful environment, where is Mother Nature? Where is my dear Mother Nature in this picture? Is she so ignored?", he thinks.

Father Time walks on. His path leads to a red brick university building where Professor Kant is reciting one of his critiques. Littte student Humboldt is writing down the method on his slate. "Hmm, this certainly is Enligthenment under these smoggy darkening clouds. A true second generation university", he whispers as he slips by.

Father Time walks on. The Land of the Future stands on the horizon past the steam engines, past the blast furnaces, past the energy plants, oil plants and the bio-industries. Every single machine has damaged its environment and Father Time walks on coughing.

Father Time walks on. Now he comes to a carefully managed piece of green. Father Time walks on, on to a steel bridge that leads to a straight lane with a black tarred surface marked with white stripes. Interestingly shaped, aerodynamic vehicles speed, here and there, some guided by people, some not. People are stressed, time is money. My hourglass runs like water in these lands", he cries. "I must hurry otherwise I will miss the lot".



Father Time runs on. He comes to a setting with green lawns where teenagers, wearing flowers in their hairs, discuss philosophical topics. In passing he noticed Auguste Rodin thinking, now, he meets people all running to keep up, wearing neat business suits. Everyone is shouting about business, and money, and the important hard currency and how time is money. Competition seems to be the key to this Land of the Future.

Father Time walks on. "What is this?", he thinks, as he looks at a new structure, a third generation university. The building is not yet finished. However, inside teachers and students act as peers and handle their computer technologies simultaneously. They network, talking together, machine and man. Once again Father Time breaths clean air, "But man coupled to the machine, does he have a better life?", asks Father Time.

Looking back, Father Time sees that several universities on the orange road are pulling young students into their old-fashion structures. Father Time thinks, "Why are they pulling so hard? It is not fair to treat the student as hard currency, let then make choices, nurture them as they did in the universities of the Lands of the Past. Challenge them, and they will deliver. That will do the trick", he mumbles, "Hmm".

Father Time walks on. Further into the Land of the Future thinking deeply. To progress, he thinks, universities must abandon the Instruction Factory paradigm of the orange brick road universities to make place for the Knowledge Academy paradigm of the blue road universities. We must valorise the, as yet unharvested, knowledge of our student cohorts. Finally he yells:"Universities, Facilitate!"

Father Time walked on …

… to Chapter 8 …

3 Higher Education in Historical Perspective

Zarathustra aber sahe das Volk an und wunderte sich. Dann sprach er also: "Der Mensch ist ein Seil, geknüpft zwischen Thier und Übermensch, ein Seil über einem Abgrunde. Ein gefährliches Hinüber, ein gefährliches Auf-dem-Wege, ein gefährliches Zurückblicken, ein gefährliches Schaudern und Stehenbleiben."

"Was gross ist am Menschen, das ist, dass er eine Brücke und kein Zweck ist: was geliebt werden kann am Menschen, das ist, dass er ein Übergang und ein Untergang ist."

From Also sprach Zarathustra: Ein Buch für Alle und Keinen by Friedrich Wilhelm Nietzsche (1906)

Nietzsche's Zarathustra, quoted above, was written in a earlier époque but humans have always developed themselves, it is intrinsic drive (Maslow, 1943), and higher education has also developed through the ages. Education should more or less be a mirror of the cultural settings in which we move. To understand the social and cultural settings in the Western world we explored multiple developments, some of which had a stronger relationship with education and others a less direct relationship. Still the developments addressed in this chapter have important messages. Most are placed in a historical perspective, but are slightly detached to help us explain certain phenomena. This investigation into such developments was designed to help answer the first research sub question "*What developments have had or have an influence on higher education?*"

3.1 HISTORICAL PERSPECTIVE ON WESTERN EUROPEAN UNIVERSITIES

European universities have a long history. Many forms of tertiary education were founded all over Europe. The University of Constantinople, founded in 849, is considered by some to be the oldest higher education institute of Europe (Vogt, 2005). The University of Bologna was founded in the year 1088, followed by Paris (1150) and Oxford (1167). However, one may argue that the ancient Greek academia of Plato or Aristoteles' lykeum (Aristoteles, 2005) were the first universities, followed by Roman retorica institutes (Assendelft et al., 1997) and Celtic druidic universities (Berresford Ellis, 2003).

We were looking for university archetypes (Jung, 1995), defined as the original model of something from which others are copied (Cambridge University Press, 2001), to stand as a model for universities over the last millennium since the Renaissance. Today, a university may be defined as an institution of higher education and research, which grants academic degrees such as bachelor, master, and doctorate (PhD) in a variety of subjects. The word university is an abbreviation of the Latin words 'universitas magistrorum et scholarium', which stands for a community of masters and scholars (Vogt, 2005). It is derived from the Latin word 'universitatum', which means the whole of the related people. Students are essential for a university and should be respected members of the intelligent collective. Their intelligence is the human capital or social capital, as James Coleman calls it (Coleman, 1988), with which a university functions. Students' knowledge and skills will be valorised as soon as they enter the work force.

3.1.1 First Generation Universities or Scholasticism

Scholasticism was a method of learning taught by the academics of medieval universities in the period of about 1100 to 1500, it was the dominant western Christian theological and philosophical school of the Middle Ages. Scholasticism was stimulated in the monastic and cathedral schools and was mainly inspired by the famous Greek philosophers Plato (427 – 347 BC) and Aristotle (384 – 322 BC). Anselmus of Canterbury (1033 - 1109) with his adage "I believe to know" and Thomas of Aquino (1225 - 1274) with his 'Summa Theologicae" flourished in this period of scholasticism (Vogt, 2005). The synthesis of Greek Philosophy and Christian Doctrine of the Latin fathers was the heart of scholasticism. The first generation schools were enriched with an enormous influx of knowledge from the Islamic world as a consequence of the crusades and of Spanisch monasteries preserving information after the fall of Islamic Spain in 1492. Intense exchanges of knowledge took place between these worlds and the schools began to develop into universities (Pederson & North, 2003).

The first generation university commonly had four faculties, theology, law, medicine, and artes liberales. The artes liberales comprised grammatica, dialectica, rhetorica, arithmetica, geometrica, astronomica and musica (Vogt, 2005; Wikipedia, 2007; Wissema, 2005). At the time, Latin was the international language, lingua franca, of scholarship and the Christian church owned much of the intellectual capital (Wikipedia, 2007). The higher aim of the medieval university was to enlighten the world and promote the unquestioning obedience of the people to God and his servants (Vogt, 2005). The servants, such as the pope, emperor, and king, were the icons of the day and sources of income for the cities in which universities were established. This financial support for the university was probably the reason the phenomenon spread so rapidly in Western Europe (Wissema, 2005).

A rector and chancellor led the first generation university. The rector was elected and the chancellor with his higher rank was commonly appointed by the church, sometimes even by the pope. Faculties began as communities of individual teachers teaching groups of students in hostels which went on to become colleges. The better teachers among them had international reputations and attracted students from all over Western Europe. Universities had teaching as main goal hence education was dominant. Research tasks as we know today were not conducted although exploring studies were already in place to support education.

3.1.2 Second Generation Universities or Enlightenment

Until the 18th century, religion played a significant role in university curricula, but religion diminished in importance in the second generation universities due to the great philosophers, such as Descartes, Bacon, Locke, Rousseau, Hume, Kant, and Hegel who searched for the fundamentals of rational and empirical approaches to learning. These approaches led to Enlightenment, the period in 17th and 18th century Europe when people began to reason about philosophical developments related to scientific rationality, rather than religion and tradition. According to Wilhelm von Humboldt the mission of universities was to pursue scientific knowledge. The second generation universities focused on demonstrating the process of discovering knowledge and teaching students to take account of fundamental laws of science in all of their thinking, instead of preaching factual knowledge. Humboldt is considered to be the founder of the education system that became the dominant role model for second generation universities. Science and its research activities became dominant within universities from the 19th century onwards (Leezenberg & Vries, 2004).

At the second generation universities the professors executed both education and research in their topics. Students could conduct research in seminars or laboratories and began to produce doctoral theses with scientific content (Downer, 2004). Gradually the teaching language became the mother tongue. Probably because of this the international mobility of lecturers and students was limited drastically. The second generation university became a research institute with many specialised mono-disciplines, divided into even more specialised sub mono-disciplines. Faculties in theology, law and medicine continued as a whole, but the artes liberales were divided into natural sciences, such as mathematics, physics, chemistry, pharmaceutics and biology, and the arts, such as literature and humanities, with engineering, economics, and social sciences added later in the 19th century (Wissema, 2005). By the end of the 19th century, the Humboldtian university model had spread not only throughout Europe but also throughout the world.

With respect to the universities' management every faculty was led by its dean, the senate as board of professors with the rector magnificus as chair, and the board of curators. The influence of the church was eliminated in most cases, and that of the students. Slowly the state came in to take over the role of the church. European universities were focussed on science and research, and their structures and philosophies shape the way today's university is structured (Wissema, 2005). Within the universities, the departments have an official organisational hierarchy with a professor as head of the department or chair or college, supported by associate professors and assistant professors, and staffed with a number of facilitators.

3.1.3 Third Generation Universities up to Sustainability

Higher education became available for the masses in the 1960s and the influx of non-elite, non-aristocratic and female students into European universities began to challenge the Humboldtian university model. Suddenly a variety of students appeared with different backgrounds and with different expectations. Universities were no longer elite places and many students at this time began to receive governmental support. The universities received subsidies proportional to their number of registered students, hence, competition to recruit more students began to take off.

It seems that we are on our way to a third- generation university, multiple international boards have been set up to discuss the future of the universities (Gibbons et al., 1994; Mohrman et al., 2008; Sainsbury of Turville, 2007; Weber & Duderstadt, 2004). On June the 19th 1999 twenty-nine European ministers of higher education met in the 'Aula Magna' at the University of Bologna to confirm the 'Declaration of Bologna', which laid out the principle objectives for higher education in the European area as a means to increase Europe's competitiveness in the field (Wende, 2001). One of the objectives was to create a European Higher Education Area (EHEA) without borders by the year 2010, this will be built on four pillars (Weber & Zgaga, 2004).

1. Each European country had to adopt a system articulated around the bachelor, first cycle, and master degrees, second cycle. The first cycle is dedicated to obtain basic skills for scientific knowledge and methodologies. The goal of the second cycle is to obtain more specialised knowledge in a specific discipline using a multidisciplinary or interdisciplinary approach.
2. Mobility programs were set up to encourage student mobility coupled with the introduction of the European Credit Transfer System (ECTS), and recognition of the degrees or years accomplished at other European universities. The language of communication, lingua franca, was set as English.
3. Accreditation with formal assessment processes, was set in place to determine whether an institution has reached a 'standard of quality' that can be considered sufficient.
4. Quality assurance was also set in place to encourage universities to pay greater attention to improving their quality of teaching and research.

In a the second initiative, in 2000, the council of ministers created a European Research Area (ERA) aimed at networks of excellence, a European research council, and European countries committing to spending up to 3% of their gross domestic product (GDP) on research. Other issues of a lesser concern were: promotion focused on learning instead of teaching, Use of information technology in teaching and distance learning, life-long-learning, under-representation of low-income social classes, different fee systems in the several countries, quality of pre-college education, service to the community, political correctness and replacement of teachers who are leaving.

To be a competitor in the educational field and to attract top students a university might focus on knowledge valorisation (Mohrman et al., 2008), increased and faster transition of research and engineering thoughts or ideas into innovative applications using market principles (Gibbons et al., 1994). Karl Marx introduced the term Kapitalverwertung, valorisation in English, in his book "Das Kapital; Kritik der politischen Oekonomie" (Marx, 1890). Top universities already work intensively with public and private research institutions and create incubator plants near their campus (Ferren et al., 2001). Valorisation of knowledge is becoming an increasingly dominant phenomenon. Many life science and IT industries are major spin offs from modern universities and hardware and software incubators have become increasingly market-oriented. As a result third generation universities will probably grow an entrepreneurial state of mind where the sharp boundaries between the mono-disciplines are overcome by increasingly multidisciplinary challenges and where sustainability is a main goal. The faculty as building and boundary to hold the mono-disciplines will be reformed into knowledge groups with special abilities to undertake particular multidisciplinary challenges. Such smaller knowledge groups will need to be supported in more effective and efficient ways, commonly by shared service centres (Wissema, 2005) in which standardised support is provided on a sense and respond basis (Nolan & Croson, 1995).

3.1.4 Concluding Remarks

The first generation university aimed at education. Books were rare and hand-written and knowledge was concentrated in the minds of the teachers and handed down to the students verbally, students were examined viva voci, orally. Around 1440 Johannes Gutenberg invented the printing press and his printing method can be credited with a revolution in the production of books, and more importantly, for fostering the rapid spread and development of thinking in the sciences, arts, and religion through the transmission and later, translation of texts. The scarcity of written materials decreased with printing, copies could be made, and it certainly helped to make the second generation national universities possible, with their extended libraries in their national languages (Downer, 2004). Traditional content-based and teacher-led lectures can be justified in situations in which books are scarce or expensive as was the case for the first generation university, but this is not the case today. Ready and instant access to information is a feature of the modern electronic educational environment (Brown & Duguid, 1996). Now, at the end of the second generation university, computers and their networks spread knowledge more quickly and further than any book. Within a few decades scarcities of knowledge, information, communication and presence will disappear completely.

h. We wondered how higher education can take advantage of instant information access within the learning and working environment.

Progress from a first generation university to a second generation university may not be sensed as radical by the staff and students, most changes that have taken place have happened in a slow and hardly noticeable way, yet there are really quite discernable characteristics that can be observed between first, second, and third generation universities. Universities have moved from:

- an education orientation to a research orientated approach to a valorisation oriented approach
- Latin as the lingua franca to using the mother tongue of a country to using English as the language of instruction
- high student mobility to little student mobility, to virtual and again physical mobility
- oral dissemination to journal dissemination to electronic dissemination of knowledge
- religious governance to secular governance via a government to being ruled by market forces

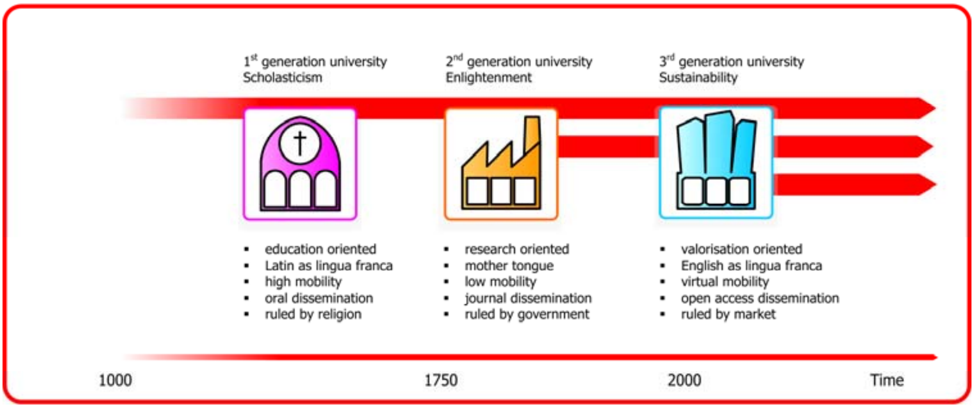


Figure 7: University Generations with Typical Characteristics by A.H.W. van der Zanden

A rough timeline overview is presented in Figure 7 in which the typical characteristics of each generation are listed; the characteristics of scholasticism to Enlightenment, and onwards. As the second generation took over dominance from the first generation university the former generation did not disappear, it was decreased in importance, disminished in its existence. When a society progresses it builds on its achievements which does not mean that its history is always forgotten. There will be communities who choose to live on in a specific way. After more than three centuries aspects of the first generation university are still alive and kicking, although through the merging of many institutes they nowadays occur as faculties or partner institutes. The model no longer dominates learning.

Will aspects of the second generation university endure?
Its fundamental teaching of science will be less valued by the economic driven research programs of tomorrow. According to those supporting the third generation university such research is only interesting when its outcomes produce 'value for market'. Ambitious researchers will follow the global trend of valorisation, while practioners of fundamental research programs will resist such market pressures and endure with their, in the end, possibly non-profitable investigations.

Multiple micro-trends (Bakas, 2009) have been observed, such as mass education, adoption of information and communication technologies within education, heterogeneous student cohorts, English as the language of instruction, and funding for research activities other than direct subsidies. Such micro-trends are rooted in a search for additional financial income and give rise to valorisation. In the last decade, valorisation of knowledge has become an important trade product. It will probably grow into a dominant position which means that we must ask ourselves how the university of today should cope with such developments. To date education and research have been the primary processes of the university, but it seems valid to assign valorisation as a third primary process next to education and research.

i. ***We wondered how valorisation as third primary process can be embraced and implemented within higher education.***

3.2 Changes in Society, Science, Technology, Workforce and Education

In the middle ages, the pope, emperors, kings and queens were the rulers of society and for such reasons they also held ruling power over the first generation universities. This old order, the ancient regime, fed the cry for freedom from the majority of the subjected people. Great names such as Jean Jacques Rousseau, François-Marie Arouet, better known as Voltaire, and Immanuel Kant as modern thinkers of the Enlightenment stood strong and proclaimed a need for free thinking and free behaviour. Although Voltaire was the great propagandist for the French Revolution the more powerful voice came from Rousseau with his words "A man was born free, but everywhere he is in chains", however, the most powerful influence in free thinking probably came from Kant, even today his 'Kritik der reinen Vernunft' (1781 and extended version in 1787), 'Kritik der praktischen Vernunft' (1788), and 'Kritik der Urteilskraft' (1790) count as some of the most influencing thoughts for the Enlightenment (Kant, 1787, 2004, 2006).

Following the French Revolution there were many other revolutions and civil wars throughout Europe and Northern America, although in England replacing the old regime began a decade earlier. These revolutions were the preparatory years for the industrial ages with its technological inventions. As Manuel Castells argues social developments are inseparable from changes in technology (Castells, 1996) and so are technological changes discussed in the chapter. The industrial era coincides with the second generation university and engineering education as discipline came into being because of the high demands of educated engineers. Many schools of engineering were set up to meet these demands, these varied in format, in level, of eduation and were found throughout Europe.

3.2.1 Changes in Society

Our society is a complex multi-faceted system with unforeseeable movements; it is not a smooth and straight progress of developments but it can be seen an ill-structured construct of different views, technologies, cultures, peoples and many other things. Harry Lintsen et al give several characteristics that can be used to delineate societal changes (Lintsen, 1992, 1993a, 1993b, 1993c, 1994a, 1994b):

- demographic transitions such as decreased levels of birth and mortality rates
- increasing interference of local and national governments concerning societal life, with extensive bureaucratic departments being set up to control these interventions
- democratisation, which is visible in voting rights, and the existence of politic parties, ideologies and propaganda methods that are used to mobilise people
- growth of metropolitans where specific life styles come into play with individualisation and secularism as leading principles
- more significance is attached to obtain an educational degree and this assigns important status and position
- industrialisation, mechanisation, automation and scalability of production and productivity
- tremendous growth of mobility of people, ideas, services and goods due to extensive transport and communication possibilities

A new society emerges when, and if, a structural transformation can be observed in the relationships of production, in the relationships of power and in the relationships of experience (Castells, 1996). According to Castells we are arriving in the 'information age' where businesses are increasingly based on intangible assets (Bryan & Joyce, 2007). The value of a company is no longer derived only from stocks, machinery and buildings but rather from knowledge, competencies, patents and client focus. According to Lekanne Deprez and Tissen the shift can be illustrated by the growing disparity between the declared book value of a company and its value in the market place. The internet companies and their growth are clear examples of such disparities (Lekanne Deprez & Tissen, 2002).

New metrics for corporate performance are being discussed for managing businesses built on intangibles based on knowledge, relations, reputation, patents, marks, software, relation bases, and intellectual property, and created by talented people. The focus is shifting from return on investment to return on

intangibles (profit per employee) and number of employees, return on capital only endures as a control item (Bryan & Joyce, 2007).
Such business metrics for the information age may be usefull for universities where educational and research output will need new metrics to meet the valorisation criteria of the 3rd generation university.

3.2.2 Changes in Science

Thomas Kuhn argues in his work 'The Structure of Scientific Revolutions' (1962) that growth in our society is not smooth, and that sciences based on it are not just accumulative acquisitions of knowledge. Science consists of a series of converging theories that are interrupted and sent in new directions by revolutions in research activities. Such revolutions are called 'paradigm shifts'. The scientific approach as such does not have to change, but beliefs and theorisations will change as the researchers perspective changes, hence the underlying theories will change although the phenomena being studied stay the same. For example our once flat earth view of the world has changed to a heliocentric view of the universe, but not the stars and planets. People have changed their positions and moved on with the new theory as the leading principle. We are no longer the centre of the universe on a flat earth, we dwell on an orb around the sun. Another example is the special and general relativity theories of Albert Einstein. Although Einstein was not a recognised scientist as such, his arguments that Newton's Laws were incomplete were accepted in the scientific community. Again, the phenomena stayed the same but the theories shifted (Bais, 2007; Einstein, 1997; Roodenburg, 2007).

Kuhn was responsible for popularising the term paradigm, which he described as a collection of beliefs shared by scientists, a set of agreements about how problems are to be understood. According to Kuhn, paradigms are essential to scientific inquiry, natural history cannot be interpreted in the absence of at least some implicit body of intertwined theoretical and methodological beliefs that permit selection, evaluation and criticism (Kuhn, 1962). Kuhn's thought is very interesting; because it helps to explain that a certain paradigm captures a whole science community within a certain leading theory. Through the centuries great philosophers have been following to diverge and converge the many movements and views, which have led us to human excellences on four dimensions of human experience (Morris, 1999):

- the intellectual dimension which leads to truth
- the aesthetical dimension which leads to beauty
- the ethical or moral dimension which leads to goodness
- the spiritual dimension which leads to unity

Empiricists, such as Francis Bacon, John Locke with his famous "tabula rasa", George Berkeley and David Hume, took the senses as their source of learning using *phenomena,* i.e. empirical appearances. While the rationalists, such as Rene Descartes, Baruch Spinoza, and Gottfried Leibniz, use mathematical reasoning and *noumena*, i.e. knowledge entities, as their source to explain and extend knowledge. Some scientists still follow the empirical way to conduct their research where other scientists follow the way of reasoning. Immanuel Kant began to unite rationalism and empiricism with his three 'Kritiks' in the 18th century, and his thoughts became very influential within philosophy: but it was Georg Wilhelm Friedrich Hegel who was the first to take the challenge of building on the works of his philosophical predecessors. Hegel worked out a complete opus with 'Phänomenologie des Geistes' (1807) as most directive and 'Wissenschaft der Logik' (1812 – 1816) as his most thoughtful works. Hegel was inspired by all existing philosophical movements and consequently combined science, philosophy and religion in his one system (Hegel, 1832).

When looking to the philosophy of science it was Karl Popper who produced seminal work in his field with his 'Logik der Forschung' (1934), in English 'The Logic of Scientific Discovery. His theory of falsification argues that we cannot find the truth by verifying or reasoning, but we can only approach the truth by deleting or falsificating the things that are wrong or do not support an assumption. The assumptions that remain will consequently become steadier and may grow into a probable theory, or may be falsified as a theory (Popper, 1988, 2002). Falsification is an extremely strick approach, however, Popper's way of working implicitly means that the research and its theories have to be within a certain paradigm, following Kuhn. When anomalies are found, and they are not mentioned or put aside or just ignored, although we must assume that they do exist, considerable valuable knowledge can be labelled unknown.

Researchers seek to both verificating data and find anomalies in general practice, verification is used to support an assumption and anomalies to demarcate the area in which the rules of the proposed theory work. Unfortunately, such outlines reduce the generic validity of a theory; and when too many anomalies occur and outlined areas can no longer connect, then maybe we have to consider a paradigm shift. According to the relativist's perspective we cannot strive for pure truth, hence we should relate such truth to finite "research programs", as Lakatos calls them (Lakatos & Musgrave, 1970). With this in mind it must be possible that multiple paradigms exist simultaniously with no mutual coherence among them (Rutgers, 1993). We can take an everyday example such as salt to explain this. The cook values the salt for its tasteful ingredient, the civil engineer dislikes salt for its damaging force, the chemist adds it as essential part of his experiment, the salt miner as entrepreneur, sees it as his income, et cetera. All of them talk in the same way about salt, only from different perpectives and therefore simultaneously different paradigms.

Educationalists, who aim at ICT-enhanced and ICT-transferred educational practices must take into account peer reviewed publications, which with its long term and slow hit rate is inappropriate for publishing their research data. Based on their experiences the new research data has to be shared with their peers as soon as possible. Publishing on the internet decreases time to publication, increases the rate of publication, but unfortunately yields no profit in scientific output when compared to publications in cited and printed journals, hence, new metrics for research output may be needed taking into account other media than paper journals. Researchers in a standing research program with an 'old boys network' of protected journals and known colleagues in peer review committees will find the research data of such modern educationalists inappropriate for matching their standards, which they consider to be their ultimate truth. If you are not a peer within their paradigm, you will be neglected and put outside the network; out of sight and out of mind. This is the second reason to set up new metrics for education and research output.

*j. **We wondered how a metric system can be fit within higher education for both education and research output.***

3.2.3 Changes in Technology

In the last two centuries many societal changes have taken place due to technological innovations, with them almost always multiple new emerging technologies (Castells, 1996). Brigth gives an approach that can be used to understand technological change or technological evolution. He sees seven trends in technology (Bright, 1963):

- increased capability in transportation
- increased mastery of energy
- increased control over the life of animate and inanimate things
- increased mastery of materials
- increased extension of human sensory capabilities
- increased mechanisation of physical activities
- increased mechanisation of intellectual activities

Industrial production gained an important position and took over from agrarian production since the second half of the 19th century. Cars and trains took over from coaches and horses, the telephone opened new ways of communication, and steam ships took over from sail. Economists at the time were convinced new waves of innovation took place periodically (Foster, 1987). During an initial innovation period the potential of new technology is revealing itself and many new entrepreneurs will try to enter the market, then there is a term of prosperity during which innovations spread and the stronger corporations stand firm and grow; then there is a period of rest where innovation no longer takes place and company take-overs dominate the market; and this is followed by a period of depression with little business activities on behalf of a company. This wave theory was first posed by the Russian econometrist Nikolai Kondratieff in the first half of the 19th century, see Figure 8 for a schematic overview of Kondratieff's theory.

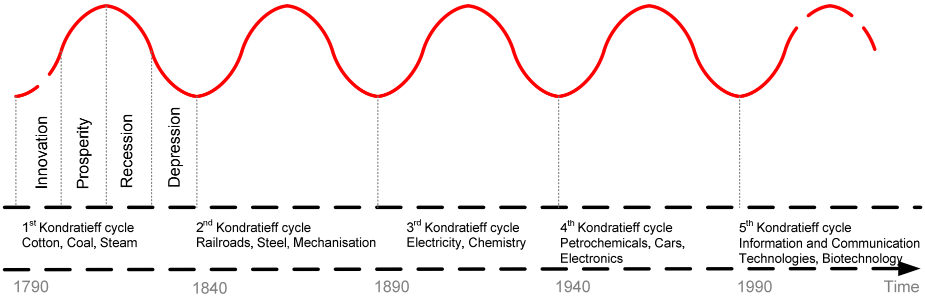


Figure 8: Kondratieff Cycles with Half-Century Periods (Foster, 1987)

The Kondratieff Cycle is a theory based on research into 19th century economic behaviour of firms, which included wages, interest rates, raw material prices, foreign trade, bank deposits and other data. Kondratieff was convinced that his studies of economic, social and cultural life proved that a long-term order existed for economic behaviour and that this could be used for the purpose of anticipating future economic developments. He observed certain characteristics about the growth and shrinking phases of the wave. Among them, he detailed the number of years that an economy expanded and contracted over each part of a half-century long cycle. Industries suffer the most during a down wave, here they invest in technology which plays a significant role in leading a company out of the contraction phase towards to the next inclining wave (Christensen, 1997; Foster, 1987; Foster & Kaplan, 2001; Perez, 2002).

In the 1930s Joseph Schumpeter elaborated on the wave theory (Schumpeter, 1939) and showed that the first wave of industrialisation took place from 1790 until 1840 supported by the textile industries which grew out of the opportunities provided by coal and steam. The second wave between 1840 and 1890 was directly caused by the advent of the railroads and mechanisation of production processes. A third wave from 1890 to 1940 began with electrification, progress in chemical sciences and the petrol and diesel combustion engine. The fourth wave from 1940 to 1990 was based on electronics, petrochemicals and cars. The present fifth wave, built on information and communication technologies, networks, biotechnologies and the tremendous progress that has been made in physics and mathematics, will probably endure into the first halve of the 21st century (Foster, 1987). If we elaborate on the Kondratieff cycles the next wave will be emerging around the 2040s. Ray Kurzweil argues that computers will take over the human's intelligence by that time (Kurzweil, 1999) and according to Steven Cherry wireless connections will be faster then wired networks (Cherry, 2004).

Kondratieff's wave theory is not commonly accepted, there is an ongoing discussion regarding its validity, most would argue that Kondratieff's theory fails in the 1960s as Figure 9 shows. Yet the wave theory can be used as a guiding principle to give insight into the new idea of evolution economics or innovation based developments (Foster, 1987; Perez, 2002).
Most cycle theorists agree on the five waves cited above, although around the 1960s the financial part of the cycle broke and since then continuous economic growth has taken place, with some downturns, but a general strong growth upwards, which does not fit with the wave theory as posed by Kondratieff and his followers. The fourth wave was the last of the truly industrial shaped waves, the wave we see now probably is shaped by access to information as Michael Alexander argues (Alexander, 2002), thus it is informational in character. This informational character coincides with the changes in higher education dating from the 1960s.

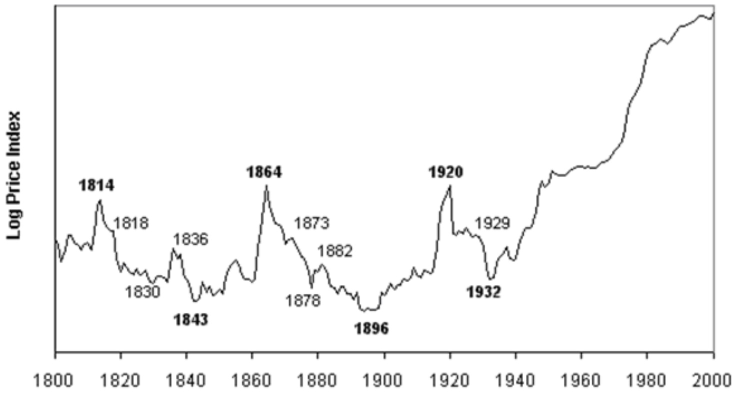


Figure 9: The Kondratieff Cycle taken from Michael Alexander, 2002

Castells argues that the United States especially has been able to exploit the potential of the new information technologies of this fifth wave, and thus it has moved rapidly from an industrial to an information mode of production (Castells, 1997b). In the fifth wave, businesses have changed their way of work using information technologies. The back end business processes, such as logistics, finance and administration of modern corporations have been transposed onto internet technologies (Tewoldeberhan, 2005), the old-fashioned local legacy systems are gone. Today's businesses are faster, cheaper to run, more flexible, more dynamic and also more volatile because of the influence of venture capitalists and thin employment contracts (Perez, 2002).

Another important issue is the 'democratisation of innovation', users of products and services are increasingly able to innovate for themselves. Moreover, most of the time such innovations are freely revealed for other interested parties through open source communities (Hippel, 2005). This leads to the complex way of many businesses work today, and can be seen as a better fit for the Internet Revolution, rather than the collapsing stock markets community is referring to as the Internet bubble (Lemstra, 2006). The internet bubble can be considered to be a hoax because money was lost by investors, but the businesses have been transformed in ways not easily visible to the stakeholders (Perez, 2002).

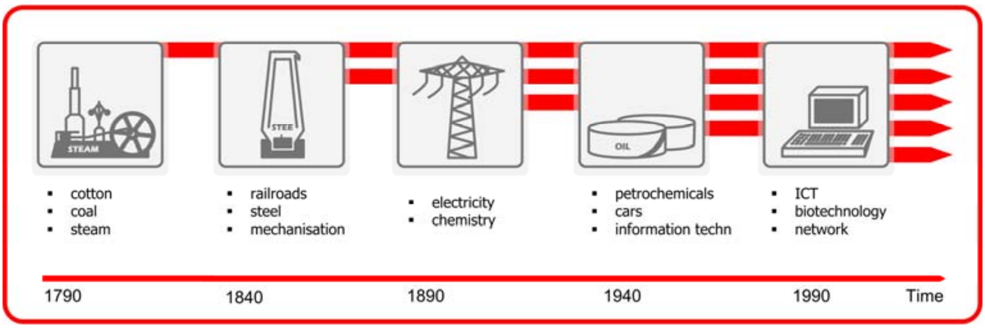


Figure 10: Technological Innovations since Industrial Revolution (Foster, 1987)

Kondratieff's greatest contribution is the idea of long business cycles, or better said, business fluctuations, and more specifically recognition of these processes within Western society. The technologies are set out in time without the cyclic waves in Figure 10. The new figure is presented to contrast with Figure 8, which tends to indicate that later technologies cause former technologies to disappear, this is not right. When a new technology takes over, it takes over, it attracts the attention, it fulfils a dominant role, it becomes the dominant technology of its environment and it is used by scientific and social communities. Use of older technologies diminish, can be spread to, for instance, developing countries, use does not die out completely 'over night'. The new technology wave will start slowly moving from country and community, though some technologies may kept in use to comply with tradition, or as reminders of history, for example, many developing countries still use steam trains powered by coal or wood, in the West we still run steam trains as tourist attractions to remind us of our past. Finally, can wave theory be used to help us plot the course of the use of education technology?

k. ***We wondered how successive technological innovations, presupposed that a next Kondratieff wave is to emerge around the 2040s, coincide with an educational technology forecast.***

3.2.4 Changes in Workforce

Over time the 'employer – employee' contract has changed in accordance with changes of industries. Long working hours for a farmworker forced of the land by mechanisation of farming turned into long working days at the factory (Marx, 1890). For many decades labour unions fought for better working conditions and labour contracts eventually achieved a working week of about 40 hours (Poel, 2002). In the information age the working environments has become more flexible where the clear distinction between work and private is blurring (Nolan, 2000).

In the last centuries a transformation from an agrarian economy to an industrial economy up to an informational economy has taken place. The revolutionary productivity gains in food production in the period from 1845 to 1945 minimised the numbers of farmers in our Western world. It was a result from the transformation of the land labourer into industrial worker based on the mechanisation of farming. The shrinking seems to be repeating in this following century started in 1945 up to about 2045 (Office in Technology Assessment, 1991). This time it is a result from the transformation of the labour force directly involved in manufacturing in the industrial economy into the knowledge worker related to the automation of manufacturing processes and the information of business processes in the information economy (Nolan & Croson, 1995). A similar pattern can be recognised for Western Europe (Drucker, 1994, 1999; Wilterdink & Heerikhuizen, 2003) and Australia (Hack, 2008).

In an industrial economy, companies divide work into activities done by two classes of workers. Companies differentiate classes by their level of education: white-collar workers are usually college educated and they work as managers and professionals such as accountants and engineers; blue-collar workers, have less education, some have graduated from high school and many often only have primary school education. The overall business model is that white-collar workers design the way that work is done codified in task definitions, job responsibilities and policies. White-collar workers also supervise blue-collar workers to ensure that they carry out the work properly. Any deviation from planning is managed by white-collar workers taking corrective action (Nolan, 2000).

In an information economy, the line between white-collar and blue-collar workers has broken down the sharp distinction between types of workers, those who design work tasks also do them. Serving customers with 'sense and respond' strategies requires workers to operate as caseworkers and cope with a much more complex work environment. Consumers further complicate the work environment with their new demands for faster product cycles and service times, which in turn require increased access to more knowledge, faster than ever before.

In an information economy another great change emerges in the employer-employee understanding induced by the internet. Castells argues that restructuring the Western corporations into more networked businesses have created new work and employment conditions. He claims that networkers and flextimers replace the full-time employees (1996). Was it traditional that employees apply for a predefined job on an employer's advertisement, printed in the local newspaper or magazine, even now with modern video calls on the internet, such as yourjob.tv. Today people nominate themselves while emphasising their skills or talents on virtual spaces such as Youtube, Linkedin, Facebook, MySpace, Livespaces and Hyves. When fortunate, they are accidently spotted by someone who is in need of their specialties. Unknown people without the old boy's network or their parents' influential connections come into the spotlight and get a one in 1000 chance

to obtain a job which normally would be unreachable. Also so-called reality series on the television channel or soaps pursue the same formula where unknown persons are becoming famous instantly when appearing in nonsense broadcasts with big prices and great challenges. These employer-employees understandings mostly aim at short term contracts with special clauses, however, when the new employee satisfies the needs of the employer, suddenly a complete new career can take off. Such new information age jobs are based on what is called ‘zero distance’ meaning inside the network, or ‘infinite distance’ meaning outside the network (Castells, 1996; Lekanne Deprez & Tissen, 2002). According to Castells, Lekanne Deprez and Tissen one can join such networks with zero efforts, with zero matter, in zero time, but one probably also must have zero expectations.
However, social software and portfolio technologies that are exploited to support such information jobs may have a purpose within higher education to support the valorisation process. Moreover, knowledge workers in the information economy meet emerging technologies that demand skills to master these technologies. This mastering is caught under what is called *literacy* on which we will elaborate in Section 3.5.

l. ***We wondered if the students and instructors of today's educational technology show signs of uses that typically belong to such technologies.***

3.2.5 Changes in Education

Periods with strong innovative activities in Western Europe started around the 1800s. The transition from an agrarian economy to industrialised economy raised demands for engineering education, which grew rapidly in the beginning of the 19th century with Germany and France in lead. The rise to the dominance of a schooling culture in engineering education in England and America took place much later because of academic training of state engineers in Germany and France. They set a powerful role model in continental Europe, which in the beginning was absent in Anglo-America. Consequently, the academic training for the private sector also started earlier in continental Europe (Pederson & North, 2003). During the late 19th century a general belief as key to international competition joined forces with a thorough transformation of economy in providing new jobs for engineers who graduated from colleges and universities (Lundgreen, 1990). The established ideas for schooling created an institutionalised chain of education systems through the centuries, today the government controls primary and secondary education severely, it prescribes multiple regulations and holds the state exams.

Table 3: Educationalists strive for new Educational Systems, taken from Veen & Vrakking, 2006

from	*to exchange for*
normalised lecture hours	*full immersion of disciplines*
severe control systems where you must redo the school year when failing for just one or more courses	*motivation stimuli based on passion*
summer holidays based on harvesting periods from the agrarian era	*more spread and broadened curricula*
talking-head instruction	*coached authentic project-based learning*
mono-disciplinary education	*multi-disciplines in social and digital community environments*

The government has been tightening its grip on the education system in the last decades and since it want to extend its influence on higher education institutes *a new cry for freedom* came up by educationalists and schools. This is a cry for freedom to unleash chains of the industrial influences from our pedagogies and educational system (Veen & Vrakking, 2006). These chains are presented at the left side of Table 3 with the proposed changes at the right.

New thinking educationalists claim that youngsters of today have additional ICT skills because they grew up with the remote control, mouse and mobile (Prensky, 2001; Siemens, 2005; Veen, 2000; Veen & Jacobs, 2005; Veen et al., 2002). Youngsters of today are familiar, not only with new technologies for learning, but also with its conceptualisation, they grew up thinking in these terms, next to adapting them. They are called digital natives (Prensky, 2001). This is very interesting, because they assume that youngsters of today possess skills not addressed yet, let alone valued in the current education system. Many corporations

engaged in e-learning in order to speed up business processes and systems. Main drives are cost savings and performance improvement of staff. Corporate e-learning is a business driven activity boosting the development of new and better technologies. Although this is not the case for the educational sector, where learning technologies are slowly adopted and introduced with a certain delay, such new thinking educationalists found strength in creating educational environments based on these ICT environments, already in operation in commercial companies. Thereafter the commercial market jumped in to support these new educational thoughts with their virtual learning environments (VLE) followed by free thinkers, such as innovative software engineers and exploring teachers with all sorts of social software tools.
However, most attempts to change education are only based on the uses of tools and means outside the classroom and logistic support of course materials. Such minor changes at the end of the education process do help, but do not transform the education and its system as such. Radical or revolutionary changes in education can only be achieved when for instance the policy changes, subsidy structures stop steering and the degree system reforms. Education as a whole probably needs a paradigm shift to change according the proposed changes as listed in Table 3. The several developments as discussed in this chapter let us believe that we are on a brink that ruptures the education establisment.

m. ***We wondered how higher education can unleash itself from the industrial chains listed in Table 3.***

3.2.6 Remarks

A significant number of scientists from several domains increasingly argue that new paradigm characteristics appear. These certainly put up the pressure for change (Bates, 2000; Brown & Duguid, 1996; Collis & Moonen, 2002; Cross, 2006; Fullan, 1999; LeGrew, 1995; OECD, 2000; Rosenberg, 2001; Rushkoff, 1999; Siemens, 2005; Veen & Vrakking, 2006).

Table 4: New Paradigm Characteristics emerge in our Society, collected from Several Authors

from	*to*
industrial society	*information society*
decentralised technology	*central supplies*
local support	*shared service centres*
self-contained organisation	*partnerships*
formal learning	*(in)formal learning*
local focus	*global networking*
only once education	*life-long-learning*
teaching and testing	*continuous learning and improvement*
instructing	*coaching*
fixed curriculum	*flexible open curriculum*
institutional focus	*learner focus*
competition based	*cooperation based*
product oriented	*process oriented*
work as task	*work as learning challenge*
school as teaching place	*community space*
mono-discipline	*multi-discipline*
corporations as outlet	*authentic learning places*
old boy's network	*zero space network*
students as output product	*students as producers*

In Table 4 an arbitrarily list of characteristics is presented. Although it shows that many new paradigm characteristics emerge, the shift for education still has to take place. Typical at the end of an era is the unaware resistance of people deeply sunken into or involved with the older paradigm, just as Kuhn indicated (1962). For instance researchers scrutinise all sorts of effects of which they assume have negative influences on the phenomenon spoken; they call these influences of such new technologies threads against the good old reliable system. Contrarily, modern thinkers aim at the positive effects or opportunities to reveal, that are ahead of them; only for that they lack proper sufficient research data to corroborate their thoughts.

Especially in educational research a competition is going strong since last few decades. Too often new ideas are not published in leading journals because the articles to publish need to build forth on standing practices - or otherwise stated - on the extension of current paradigm. Their editors belong to the older regime, hence, some modern educationalist search for other means to spread their ideas and papers. Even better, they use the very same technologies, which they preach and worship, such as wikis, weblogs, and all sorts of collaboration and communication software, caught under the term social software. Unfortunately they stay out of sight of the current powerful researchers who are considered the ones able to start scientific discussions within their current old order networks. Consequently, a new social paradigm must wait for a ripe moment to burst through. As a thought, one could consider such publications on modern media as output for both education and research, but again, appropriate metrics are needed.

3.2.7 Conclusion

Many microtrends emerge indicating that a social paradigm, based on the information age, is waiting to come through. Examples are:

- businesses based on intangible assets
- technologies changing and speeding up business processes
- product life cycles growing shorter
- education under pressure
- increasing rate of drop outs
- ICT considered obvious in our society
- job hopping considered normal
- job application changing completely
- electronic networks overruling old boy's networks
- educationalists diverging and opposing current research allowances
- replacing consumables instantly, not repairing them anymore
- increasing workload
- serving customers with sense and respond strategies
- using electronic devices as memory
- blurring distinction between work and free time

Rushkoff states that young people are less entrenched in and committed to business-as-usual, hence, they appear much more willing to accept cultural change as a natural, even pleasurable, evolutionary process. "From the young people's perspective, the new sorts of games, sports, television programs, fashions and interactive media that they embraced in the past decade teach them to cope with strategies for the chaotic, highly networked culture of which we are fast becoming a part" (Rushkoff 1999). Educational researchers of current paradigm aim at scrutinising the negative effects of such modern technologies resulting in widespread academic discussions. In the last few years, a huge discussion has been started in the Netherlands between keepers of the 'instruction factory' paradigm and followers of the 'modern pedagogy of network learning'. The keepers organised themselves in an association called Beter Onderwijs Nederland (BON) with chairman Ad Verbrugge (Verbrugge & Verbrugge-Breeuwsma, 2006). In their manifest they laid down their criticism in order to start a 'back-to-the-old-days-of-firm-instruction' dialogue with politicians, teachers, educationalists and parents. The new thinking researchers and educationalists aim at just emphasising the new skills which the youngsters gain from using modern technologies (Veen & Jacobs, 2005; Veen & Vrakking, 2006).

n. ***We wondered if the VLE as modern technology has led to new pedagogies within higher education.***

Kuhn's argues that typical developmental patterns of a mature science are the transition from one paradigm into another through a process of revolution. Consequently, the older conceptual view is replaced by a new one. Kuhn argues that novelty only emerges with difficulty, which is manifested by resistance, against an unknown expectation at the background. Such characteristics sound familiar because similar challenges and

resistances occurred in politics (Machiavelli, 1513), in education technology (Veen, 1994), in society (Castells, 1996), and with technologies in general (Nolan & Croson, 1995).
What does that all mean for the teachers' profession? Will they continue doing their job as were shaped in the industrial age? Or is some sort of change to be expected as what happened to farmers when the industrial age took over, just as the change for factory workers when the information age took over?

In the last few years another discussion emerged how the teachers' job is to be reshaped. It is of no discussion that teachers are needed to do their pedagogical goals, but according to new educational thinkers the way of doing such important jobs must be adapted to the younger generation, which grew up with ICT. Not only because the teachers are complaining about the increasing workload and their possible lack of ICT skills, but also due to social pressures, it is to be expected that soon a breakthrough must come to discuss current practices.

o. We wondered how the teacher's job can be reshaped to face the many microtrends.

It is no longer the ten to hundred citations of the written texts in journals that grow tremendously, but the thousands to millions of pageviews or hits of online search-mechanisms to quote presentations, videos, sound tracks, games, keynotes, weblogs, wikis, et cetera. That is not for fun only, but for statements, arguments, how to's, facts, advises, hypotheses, meanings and reasons. With a tremendous speed we are escaping the scarcity of information, whether formal, informal, valid or invalid. It is to be expected that a breakthrough must come to discuss educational and scientific output. New metrics shall be needed to meet the developments on other media than books.

Unfortunately, such modern internet objects are not automatically valid or based on scientific reasoning and to date hidden between the dump of all sorts of information. However, Open access movements are growing and breaking down the fortresses of old regime publishers to gain scientific openness that suits our modern times. When such openness is achieved gradually more information resources will be valid and truthful. One significant example of public open information is Wikipedia, with more than three thousand professionals feeling responsible for the online-published articles. Such a huge community cannot longer be ignored by the merely ten folds of hired professionals when an encyclopaedia is made according to the old rules. The open movement is really pressing the discussion concerning open content, hence, a breakthrough is expected in opening up instruction-based lectures, information sources and knowledge bases from the university's intellectual knowledge properties. Coaching, instruction, assessment, valuing and giving out degrees and certificates remain the university's added values. In Chapter 8, the epilogue, we will address an organisational structure for next generation higher education and differentiation of the teacher's profession.

3.3 From Electronics to Information and Communication Technologies

The transistor can be assigned originator of what we call the discipline of Information Technology (IT). Due to the miniaturisation of the transistor many innovations came to the market. It led to very sophisticated microprocessors, to tremendous facilities such as handy equipment, applications, tools and commodity goods. Also the computer, firstly used for military purposes when they were as big as small houses, followed a remarkable path through industry to science institutes, to small and medium-size enterprises, into our society and education. Many sorts of information systems based on computers and underlying disciplines were developed, such as supercomputing, office automation, desktop publishing, databases, support systems, content management systems, and of course networking and communication systems.

At a much later stadium the discipline of information and communication technology (ICT) was recognised. Of course analog communication technologies, such as the phone and walkie-talkie, exists for a longer period, but the term ICT is a derivative of IT because of its digital communication. Nowadays also the former analog communication tools, such as telephone, telex and fax, are shared under the ICT anagram. In this section a brief historical overview is given of inventions and innovations that are counted to information technology, such as information systems, networks, computers, hardware and software.

3.3.1 Transistor as most Influential Invention of Information Economy

The transistor is an influential invention that has been transforming the world of electronics that had a huge impact on computer design. The first generation of computers until the 1950s used vacuum tubes, thereafter the second generation of computers used transistors, since the 1960s the third generation of computers used integrated circuits, and since the 1970s the fourth generation of computers used microprocessors which became available to the masses. The fifth generation of computers may bring us biochips or nanochips, but those are still in the laboratory (Bellis, 2003b).

Transistors replaced tubes in the construction of computers. By replacing bulky and unreliable vacuum tubes with transistors, computers could now perform the same functions, using less power and space. In designing a complex electronic machine like a computer it was always necessary to increase the number of components involved to make technical advances. In 1961 the first commercial available integrated circuits (IC) came from the Fairchild Semiconductor Corporation. All computers then started to make use of '*chips*' instead of the individual transistors and accompanying parts. Texas Instruments first used the chips in airforce computers and later to produce the first electronic 'portable' calculators. The original IC had only one transistor, three resistors and one capacitor and was the size of an adult's pinkie finger. Today an IC smaller than a cent is holding hundreds of millions of transistors.
In November 1971 Intel introduced the world's first single chip microprocessor in which all parts, that made a computer '*think*' (i.e. central processing unit, memory, input and output controls), were placed. Programming intelligence into inanimate objects had now become possible (Bellis, 2003b). According to Ray Kurzweil computers will be more intelligent than humans somewhere around the 2040s.

Gordon Moore, cofounder of Intel, is widely known for "Moore's Law" in which he predicted that the number of transistors the industry would be able to place on a computer chip would double every year. In 1995, he updated his prediction to once every 18 months. While originally intended as a rule of thumb in 1965, it has become guiding principle for the industry to deliver ever-more-powerful semiconductor chips with proportionate decreases in cost (Schaller, 1996). Even today, Moore's law is still going strong.

3.3.2 Information Technology as Human's Assistant

The computer made tremendous impact on business strategies and research supporting processes. The first applications of computers were in the science domain for United States national defense purposes. Scientific and engineering departments in large organisations such as Boeing have a long history of computer uses too. IBM, in the mid sixties, has been bridging scientific computing and commercial computing.

The computer has been adopted in all sorts of business processes from the 1960s onwards. The first commercial applications generally included accounting with automated tasks such as payroll processing and general ledger. The applications portfolio evolved by at first automating low-level operational support tasks within a function, such as inventory control, shop floor control and scheduling in manufacturing or plant. These sorts of applications were executed by mainframe computers, which were central calculation units connecting to multiple satellite input terminals. Such displays with integrated keyboards were placed in the workplace of the few people who were allowed to work with it after special dedicated training. The central calculation units were called electronic data processing (EDP) machines.

After sufficient automation of low-level operational support tasks within functions, the organisation integrated automated tasks within a functional department. Management control activities were automated successively, such as production operations management, accounting management and human resources management. The continuing improvements in technology increased the overall number of business functions that could be automated (Nolan, 2000).

Scientists used workstations next to supercomputers from the 1970s onwards, and since the 1980s the personal computer came into the office, together with the empowerment of clerks and managers (Block, 1987). This empowerment boosted the need for local databases and information systems, due to the manager's growing responsibilities. The personal computer gave them the opportunity to arrange tailor-made financial abstracts and management summaries.

As the demand for financial information grew other information was desired, information about manufacturing and operational processes were gathered and performance indicators were defined to give empowered managers an insight view from out of their desks. Empowered managers, later on called integral managers, demanded figures on shorter time periods instead of the annual figures. Due to such demand the databases evolved into information systems. Again due to overall information needs the independent operating information systems were evolving into enterprise wide information systems and enterprise resource planning (ERP) systems.

As a result of such technology's uses in the corporate sector a major shift took place in the organisational concept of a computer, from machine which automates work, up to an enabler of a new information resource that could be leveraged by workers to create value. The computer as technology could make managers, workers and students more productive. The idea was not simply to replace workers with computers such as robots in the manufacturing sector, but to leverage workers with computers especially in the services and educational sectors (Nolan, 2000).

3.3.3 Information Technology Enabled Communication

In 1969 work began on the Arpanet, grandfather of the Internet. Designed as a computer version of the nuclear bomb shelter, Arpanet protected the flow of information between military installations by creating a network of geographically separated computers that could exchange information over a newly developed protocol called NCP (Network Control Protocol), a protocol stands for rules how computers interact. Four DEC PDP computers were the first connected in the original Arpanet. They were located in the computer research labs of UCLA, Stanford, UC Santa Barbara, and the University of Utah. As the network expanded, different models of computers were connected, creating compatibility problems. Consequently, a better set of protocols called TCP/IP (Transmission Control Protocol / Internet Protocol) were designed in 1982 (Bellis, 2003a). To send a message over the network, a computer breaks down its data into IP (Internet Protocol) packets, like individually addressed digital envelops. TCP (Transmission Control Protocol) makes sure the packets are delivered from client to server and reassembled in the right order. Under Arpanet several major innovations occurred, such as email (or electronic mail) with the ability to send simple messages to another person across the network (1971), telnet, a remote connection service for controlling a computer (1972), and file transfer protocol (FTP), which allows information to be sent from one computer to another in bulk (1973).

As non-military uses for the network increased, more and more people had access. The network communication software (Internet Protocol) was soon being placed on every type of computer. Universities and research groups began to use in-house networks known as Local Area Networks (LAN). These in-house networks started using Internet Protocol software to connect from one LAN to another. In 1986, one LAN branched out to form a new competing network, called NSFnet (National Science Foundation Network). NSFnet first linked together five American supercomputer centres, then every major university, and it started to replace the slower Arpanet (which was finally shutdown in 1990). NSFnet started to form the backbone of what we call Internet today.

3.3.4 Information Technology Enabled Companies

One of the major means for businesses to survive in the information age is to create alliances with partners (Tewoldeberhan, 2005). Organisations are increasingly interested in online connected business networks to adapt to the continuing changing market for improving performances. The market push presses an organisation to react and respond dynamically, therefore business processes need flexible architectures with business modules or building blocks that are put to work or released from it. Dynamic shaping of such business's service oriented architecture (SOA) is called orchestration (Ligthart et al., 2005).

The needs of an organisation were met by vertically aligned or container-based information systems that supported specific organisational domains, such as sales, production, distribution and logistics in the early years of information systems. Thereafter a period of business process reengineering appeared where the focus was on horizontally integrated processes to improve the company's performance while reducing costs and cycle time. But since the wide spread internet usage the companies' processes changed dramatically. Driven by economics the businesses are focussing on what is called enterprise integration. This means that both primary and steering processes of a company are maximally enhanced by technology. The way processes are organised is completely changed from 'unit-oriented' to 'service-oriented' to 'customer oriented' technologies using web services over the internet (Nieuwenhuis, 2003).
This transformation, which some have argued is as dramatic as the industrial revolution, is changing the way we work and live in our society (Bates, 2000; Castells, 1996). Sometimes generically called the 'information revolution' or 'internet revolution', it is driven by the integration of organisational processes through enabling information technologies and systems. Organisational teams are extended to include suppliers and customers forming architectural organisations. Quality is no longer an objective; it is expected, and the focus is now on convenience. Customer feedback is replaced by personalisation, or mass customisation, producing customer orders with possible lot sizes of only one (Gulledge & Haszko, 2003). Even extended to user communities built on social software architectures for democratisation of its innovations (Hippel, 2005; Ridder, 2006), meaning that customers influence the company's development strategies.

3.3.5 Remarks

Already since the late 1960s instructional designers wanted to apply the information technology into the educational practice. The mainframe did service as computer assisted instruction, however, mainframes were not so easy to use or to access (Suppes, 1972). When the personal computer came on the market the usage of computer power became real easy. The instructors had their own machines and administration rights to alter their configurations. No strict mainframe policy rules, such as ITIL procedures, were to follow anymore, hence they could experiment freely. When the internet became available to the masses in the 1990s, about everything that stands for IT or ICT was put to a means to support teaching and learning. In 1998 the term e-learning, as a comprehensive term, was introduced by Jay Cross.

Especially in knowledge and care institutes, universities, consultant bureaus and IT and ICT related organisations, the standing workforce evolved into knowledge workers being more and more dependent on information. They have communication tools and internet at hand, they are always online, they are supported by lots of office automation hardware and software and they operate in a more flexible way, while the distinction of work schedules and private activities is blurring. Workers have gone from being deprived of data to being overwhelmed by it and they are spending more time sorting through information than actually using it to do their jobs better (Brennan et al., 2001). One could say that the scarcity of information, of communication and of presence has been overcome.
Consequently, corporations searched for new training methods to replace the out-of-office professionalisation of staff members. Corporate investment in information technology led to a new delivery for corporate training that both rivals and complements classroom-based instruction: which they also called

e-learning. Moreover, human resource development managers are applying e-learning for performance improvement of staff.
These new training methods must be supported with the appropriate technology to deliver the e-learning content. At first, electronic content was just presented through CD-ROMs and later over the internet, but organisations needed a mechanism for managing and delivering it in a digestible form to the end user in a way that this content immediately could be applied to perform better, and to help speed individuals' time to performance (Brennan et al., 2001). Systems, such as learning management systems (LMS) to support the educational administration and content management systems (CMS) to administer educational content, were followed by learning content management systems (LCMS) in order to ensure that knowledge workers spend time learning the information they need, not looking for it or sitting in a classroom hoping the instructor will eventually present it. The user who has a learning need can immediately seek the requisite information to fulfill that need and subsequently be directed to other relevant resources.

3.3.6 Conclusion

Information Technology (IT) became the backbone of many innovations. The domain came from electronics as a typical engineering profession. Since the computer was put to work as calculating unit for financial and commercial use the IT domain grew tremendously and almost every other domain started to use IT to automate parts of their processes. Considering the many developments, inventions, and innovations within the IT domain it is possible to discern four main eras.

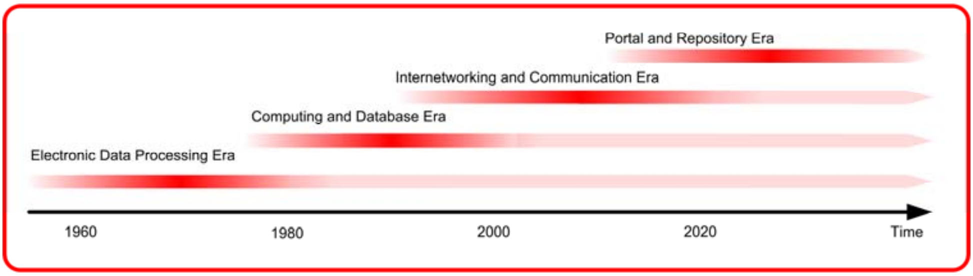


Figure 11: Overview of Information Technology Eras by A.H.W. van der Zanden

The first era concerns the 'electronic data processing' era, where the mainframe was the power tool to automate lower level business processes. It is followed by the decentralised computer power era where personnel could shape their own information needs with the help of microcomputers, or later personal computers, where databases were put to work as local information systems. This second era is called 'computing and database' era. The era in which we are now is the 'internetworking and communication' era where almost every person is capable and allowed to automate dedicated processes online, where businesses use the internet technology for their back-end business processing. The upcoming era, with back-end processes of businesses that intelligibly interact and customers are serviced through portals, is the 'portal and repository' era. The overview is presented in Figure 11.
If we consider the term e-learning or electronic-learning on itself then we can deduce technology and education as two separate disciplines bind together to find technology supported ways of teaching and learning. Companies employ e-learning to realise cost savings (such as reduction in travel expenses, opportunity costs of taking someone offsite, fewer instructors and administrators needed), others are using technology to streamline business processes and systems for efficiency reasons (such as putting software releases and FAQ's online and preventing logistic costs), and again others take a new approach to learning and or training (such as online instructions for customers' helpdesks, repair centers in the service industry, and justification rules for workers within the manufacturing industry).

p. We wondered how information technology eras are related with educational technologies.

3.4 Educational Technologies and Educational Practices

Many different sorts of technologies have been used in the educational practice since time immemorial. It all started with manual tools available through the ages such as book, pen and pencil. When the book press came to market authors, publishers and institutions recognised the opportunity to spread theological and scientific ideas throughout the intellectual world with the help of fine leather bound books (Eco, 1999).
Since the second half of the 19th century in the schools additional tools such as the blackboard and wall posters with their visual study overviews became popular (Cattheeuw, 2005). Pupils used chalk with slates and halfway the 20th century pen with notebook, while teachers could make their personal copies with mechanical typewriter and carbon paper and the cyclostyle as duplicating machine. Later on overhead projectors added an easy way for presenting notes and sketches in a classical setting. Electronic equipment was introduced to support the teachers in the classroom at the end of the 20th century, such as beamers and interactive white boards, while multiplication of lecture notes became easy with the electronic multipurpose colour copiers and scanners.

In ancient times the 'transfer of knowledge' had been in face-to-face settings such as classroom and hall or just in open spaces such as square or park. Students had to be in the direct neighbourhood of the teacher to hear and see his or her revealing knowledge. When the book appeared students could study independently, direct presence of the teacher was no longer a requirement.
Because of the possibility for self-study a new schooling system came up: Distant learning where the teacher's function changed from pure synchronous knowledge spraying within a classroom setting to a free asynchronous interaction between learner and teacher using the post office as message deliverer. With electronic technologies such communication and all sorts of logistic processes became easier, cheaper and faster. The distant learning institutes urged to use electronic ways for grading, course management and distribution, electronic tutoring, electronic help, et cetera. Consequently, learning management systems came to market for supporting these educational processes.
Meanwhile educationalists and psychologists conducted extensive research on educational theories with instructional design as main topic. The main learning theories have had very serious attention especially when new universities and learning institutes were formed. With new upcoming learning institutes the educationalists tried to work out technology enhanced educational paradigms (Steeples & Jones, 2001).

In this section different information technologies are described which were used or are used within educational institutes. Most of these found their application within a business setting before showing up in educational institutes.

3.4.1 Business Processes in Higher Education

Process theories on how businesses operate started at factories within the industrial age, but only since the last four decades such process thinking has been introduced within governments and educational institutes (Nieuwenhuis, 2003). The early hesitating attempts to describe business processes within the non-profit sector were due to the idea that public institutions should have their own unique situations. Today, it is commonly accepted that there are enough similarities between businesses processes of whatever institution. Main categories of business processes are primary client-oriented processes, their supporting processes and overall steering processes (Nieuwenhuis, 2003).

In higher education institutes the 'primary processes' are research and education. The extent for execution of research and education depends on the institute's goal. Sometimes almost no research is done when for instance universities for professional vocation are taken as subject, and sometimes no education is done in for instance institutes for applied sciences or testing objectives. In all possible combinations, education and research need their own supporting processes, for instance research needs its publishing processes, its community processes, its conferences, its laboratories, its libraries, its technologies, its administration, to name a few. Education needs its grading system, its submission system, its virtual learning environment, its instructional design, its roster, its lecture rooms, its presentation technologies, its item banks, and so on. Such supporting processes are called 'secondary processes'.

However, there are more supporting processes within higher education institutes, namely those which support the steering processes. The steering processes are the activities for setting out the institute's strategies and policies. Because multiple faculties have their own strategies and missions they have their own steering processes, called 'tertiary processes'.
A university more or less resembles the division of a business setting with a concern unit and its business units. The steering processes are assigned to the university board with its curators and its dedicated supporting systems for finance and control, personal and organisation, real estate management, marketing and communication, which we will call 'quaternary processes'.
The board of professors as the senate fulfils the steering processes on the faculty level alike the business units of a firm, which on their turn are supported with their own dedicated underlying systems alike finance and control, personal and organisation, real estate management, marketing and communication.

Table 5: Overview of University's Business Processes (A.H.W. van der Zanden et al, 1996)

Business process	***Description***
primary process	*research and education such as exploration and teaching, and valorisation as upcoming third primary process*
secondary process	*support of research and education processes such as virtual learning environment, roster, publishing and library*
tertiary process	*policy and management such as human resource management, financial planning, real estate and marketing*
quaternary process	*support of policy and management processes such as business information systems, office automation and network infrastructure*

The reason for subdivision into four business process levels is to distinguish the technologies that are applied within the primary processes aiming at education. In the next sections, we aim at information technologies, which higher education institutions adopted and on which educational practices are built, thus concentrating on the uses within primary processes only.

The 3rd generation university must concentrate on valorisation and therefore on unambiguous supporting processes. Consequently, separated supporting processes and corresponding systems for both the university board and faculty boards must be intertwined to result into one set of supporting processes. In order to streamline the underlying supporting organisation the distributed service departments must be concentrated into what is called 'shared service centres' (SSC), which support all of the steering processes for the university institute, thus concentrating and centralising the tertiary and quaternary processes. In Table 5 a brief overview is listed for the distinguished processes (Wolf, 1998; Zanden et al., 1996). It is in line with this dissertation that a third primary process called valorisation is coming up and therefore already mentioned in the table.

3.4.2 Computer Based Training as new Educational Practice

A first wave of information technology adoption within education took place in the period from the 1980s until the start of the century. The strategies that were used to put a computer at work within the education practice can be referred to as computer enhanced learning (CEL) from the student's point of view or computer assisted instruction (CAI) from the teacher's point of view. A more accurate term is '*computer based training'* (Collis & Moonen, 2002; Cross & Hamilton, 2002; Goud, 2001; Rosenberg, 2001).

Computer based training (CBT) has been remaining an important educational practice for more than twenty years now. The underlying technology for CBT is based on the personal computer (PC) or the microcomputer since the 1980s. However, the early try-outs of CBT were using mainframes in the 1970s, but that technology was not easily accessible for teachers and educationalists because of strict working regulations. CBT applications were mainly developed with 'drill and practice' in mind, doing repetitive exercises would learn a student or worker how to react quickly and appropriately (Goodson et al., 2002; Spector, 2001; Steeples & Jones, 2001).

The PC was put into action as a single-user tool for applications such as mathematics, computer-aided design, simulation programs and infinite calculation methods. Other single-user applications, provided through the parallel developments of emerging office automation, are necessary or rather obligatory for CBT. Such text editors, spreadsheets, presentation and drawing software provide the lecturer and student with a means to become computer literate.

3.4.3 Online Learning as newer Educational Practice

A second wave of information technology adoption in higher education started to take place in the second half of the 1990s up to today and is expected to remain dominant for at least another few years. The second wave is called networked learning or '*online learning*' (Cross & Hamilton, 2002; Goodman, 2002b; Goodyear, 2001; Goud, 2001; Rosenberg, 2001; Steeples & Jones, 2001). The underlying technology for online learning (OL) is a multi-user virtual learning environment (VLE). Other names are electronic or digital learning environments.

The VLE is a server-based application, which uses Internet technology and the World Wide Web for information sharing, streaming video, learning material distribution, subject matter file exchange and online communication. Learners use a client system, such as PC or terminal, to connect to the VLE. This client system contains single-user applications as developed and described above. It is assumed that the user already has the necessary computer skills, that the user is computer literate. For computer literacy special programs were set up, such as computer driving license (CDL) programs, which has been implemented in many Western countries to stimulate teachers to acquire the necessary computer skills.

Table 6: Push Factors related to Technology in Education (Collis & Moonen, 2002, p.41)

Push factors	*Computers and education, 1980s*	*Internet and education, 2000s*
Technological breakthrough	*The microcomputer.*	*Public access to the Internet and WWW.*
Social response	*We must have a computer, in our homes, in our schools.*	*We must be able to get on the internet, in our homes, in our schools.*
Social vision	*Personal computers will revolutionise society and will create powerful new opportunities for those who can handle them.*	*The information highway will revolutionise society and will create powerful new opportunities for those who can handle it.*
Commercial push	*A vast new market for goods and services.*	*A vast new market for goods and services.*
Social expectation	*Schools must not be left behind, all students must make use of computers.*	*Universities must not be left behind; all students must make use of the Internet.*
Vagueness	*Metaphors and predictions are strong, results are anecdotal.*	*Metaphors and predictions are strong; results are anecdotal.*
Pioneers show the promise	*Both in theory and practice, there are impressive ideas and examples of how the computer can enrich and re-engineer education.*	*Both in theory and practice, there are impressive ideas and examples of how the WWW and other network environments can enrich and re-engineer education.*
Educational decision makers must and do respond	*Every school must get computers, funding must be found, new initiatives are needed, policy and strategy are needed.*	*Every course must make use of the WWW, funding must be found, new initiatives are needed, policy and strategy are needed.*
The overall movement is unstoppable	*Computers are pervasive throughout society, you can't not do it.*	*Interconnectivity via the Internet is pervasive throughout society, you can't not do it.*
The rich will get richer	*An incentive and a fear.*	*An incentive and a fear.*

Information technology (IT) became information and communication technology (ICT), with the communication (C) bringing new possibilities for educational uses of technology. With communication technologies the uses of the computers grew from single-user practices to multi-user practices. Communication technologies, such as email, chat and discussion board, were introduced within higher education to support electronical dialogues between student and lecturer and between students, but also between users and intelligent parts of the VLE, for example search engines, game bots, information guides,

adaptive courses and assessments. Such two-way communication modes provided a crucial extension to existing educational practices. Online automated peer intervision became available with the help of VLEs, as did electronic portfolios for assessment purposes. Lecture notes were (partly) digitised and put online, as were video clips together with references to online-published articles using hyperlinks.
Online learning is a time and place independent way of learning. The underlying tools for two-way communication support this time and place independent way of learning, such as blended project based learning, computer mediated online instruction, online communities of practice and globally distributed collaborative design teams.

The second wave of IT or rather ICT adoption may indicate that history is repeating itself, see Table 6 for a comparison of computer uses and internet uses in education. Collis & Moonen (2002) present several push factors for the introduction of computers in education and for the introduction of Internet within education, these are indicating that history is indeed repeating itself (Collis & Moonen, 2002). However, the use of educational technology pertaining to the second wave would not be possible without the use of technology that sustained the first wave. In other words, a student cannot approach the internet with its web servers or the VLE if a client system is not available. Therefore, the two waves are successive operational technologies and this is an important distinction between the first and the second wave. *You cannot do the latter without the former, hence, it is better to talk about **'stages'**.*

3.4.4 Learning on demand as newest Educational Practice

An emerging third stage of ICT adoption in higher education is already recognisable. Both corporate and education sectors are working with repository technologies to support flexible distribution of learning materials broken up into specified learning objects. Learning objects are modular digital resources, uniquely identified and meta-tagged, which can be used to support learning. The main idea of learning objects is to break educational content down into small chunks that can be reused in various learning systems.

Learning management systems (LMS) automate the administration of training and other secondary learning processes. This includes registering students, managing training resources, recording study results and general course administration. Content management systems (CMS) manage the presentation and distribution of corporate courses and the discovery of library information. These contents of courses and libraries directly involve the learning or the primary education process itself.
Learning content management systems (LCMS), however, do not combine the capabilities of a CMS with that of an LMS as the name suggests, but LCMS's aim at the management and administration of learning content itself. It aims at the meta-tagged learning objects, which means supporting the way how content is assembled from the inside and not the administration on the outside needed for the university's administration. LCMS's manage learning content that may be complete curricula, or composed courses, or compound courses, or separate lectures, or isolated tests, or overall exams, to name a few examples. LCMS's manage for instance multimedia courses, composed out of multiple chapters, where each chapter contains multiple sections, and each section is a hotchpotch of text, sound and video. Such text, sound and video objects are the smallest learning objects with their own learning goals, they can be studied on itself or can be part of a greater whole. In this example, these are part of the section with its higher level learning objective, again the sections' objectives are part of the greater whole, which is the course. The LCMS manages the internals of learning materials, which means that it is inevitably involved with primary education processes.

An LCMS may be interfaced with the VLE in such a way that users are provided with the right subject matter. To explain such an 'educational technology chain' the student uses a client system, such as a PC, to log-in onto the VLE, which on its turn can retrieve learning objects from the LCMS to provide learning objectives for a certain course. In this way, the LCMS represents the third stage, which cannot set to work without the second VLE stage, and without the first stage based on client systems. However, outside the formal educational environment there are fast growing developments where social software portals are interfaced with repository parts of LCMSs. The repository, as heart of an LCMS, stores and retrieves the objects. Social software portals override the other LCMS features, such as workflow management and access and rights management. These developments are emerging from libraries with their main goal of making available information for the public. Libraries are interfacing each other to facilitate the 'bookshelf' where a user can find its needs. Is the object not available on the own shelf, then an alternative library is mentioned together with a means to obtain the object. Increasingly, institutes are presenting and sharing their learning materials, following the open education resources movement.

The social software portals support an additional way to look and search for subject matter. Because such materials are to be stored in any place, they need metadata for identification. Metadata are formally assigned by its owner or informally assigned by users applying ‘tags’. Based on the metadata new strong search methods are coming along. However, with the huge increase of available information on the Internet a user has to augment his knowledge for recognising obtained objects as valid. A user has to select and assess the publicly accessible learning objects on their merits. Even better, because of the open access the users are invited to analyse, evaluate and reflect on such open source objects. In this way the ‘wisdom of the crowds’ aims to increase the object’s quality (Surowiecki, 2004). Wikipedia is a great example of such co-creation (Prahalad & Krishnan, 2008).

The greater goal for flexible distribution of learning materials may be the fulfilment of regular, but demand-driven, educational (short) tracks. The learner is to be supported with a system that facilitates the opportunity to learn just-in-time, just-enough and just-for-him. The term to fetch such features is *‘learning on demand’* (Brennan et al., 2001; Brown & Duguid, 1996; Collis & Moonen, 2002; Commissie Europese Gemeenschappen, 2000; Goud, 2001; Steeples & Jones, 2001; Veen et al., 2002). This on demand buzzword or marketing concept is used today for many fields and commercials, for example service industries are using it for service-on-demand, distributors are using it for delivery-on-demand, ICT companies are using it for computing-on-demand, and publishers are using it for printing-on-demand. Therefore, we will call the third stage of technology adoption *‘learning on demand’* (LoD), which is the current upcoming educational practice.

3.4.5 Remarks

Books were valuable and scarce with the first generation university. Because books have become very important knowledge carriers they were multiplied, first only by hand, which was real professional work (Eco, 1999; Pederson & North, 2003). When the Gutenberg printing press came to market the books could be multiplied in a much easier, cheaper and flexible way. Suddenly books became available all over the European universities, which gave a boost to the translation of the original ones into the local languages. The translated books became accessible, next to research and other journals, for the local people and such spreading of books certainly worked against the mobility of teachers and students.

If this spreading of books are compared with electronic computer files than some sort of repetition is occurring. On the personal computer isolated files, such as text files, spreadsheets and many other possible formats, are stored on the local hard drives. Next to the usage of creating electronic artefacts the computer was also used to automate data acquisition and steering processes. When the network became available these files from local hard disks could be shared amongst the machines and over the internet with the help of servers and peer-to-peer connections. Libraries took the initiative in the early nineties to exchange their tables-of-content of electronic catalogues with the help of the z3950 protocol, which may be considered as grandfather of the current harvesting protocol. Harvesting is the procedure to search for tables-of-content and types-of-content over multiple connected systems with the help of metadata search algoritms.

The original thought to share catalogues among the network is slowly absorbed within educational technologies for sharing and reusing learning materials. With today’s repositories, databanks holding metadata tagged learning objects, the educational institutes can share electronic learning materials with free open access in mind. The Open Education Resources movement grows fast and gains position.

3.4.6 Conclusion

Several educational technologies were put to work to enhance educational practices. According to the distinguished technologies, the educational practices are distinguished alike. Three discerned educational practices are depicted in Figure 12 with their typical characteristics. We will discuss the corresponding literacies in the following Section 3.5.

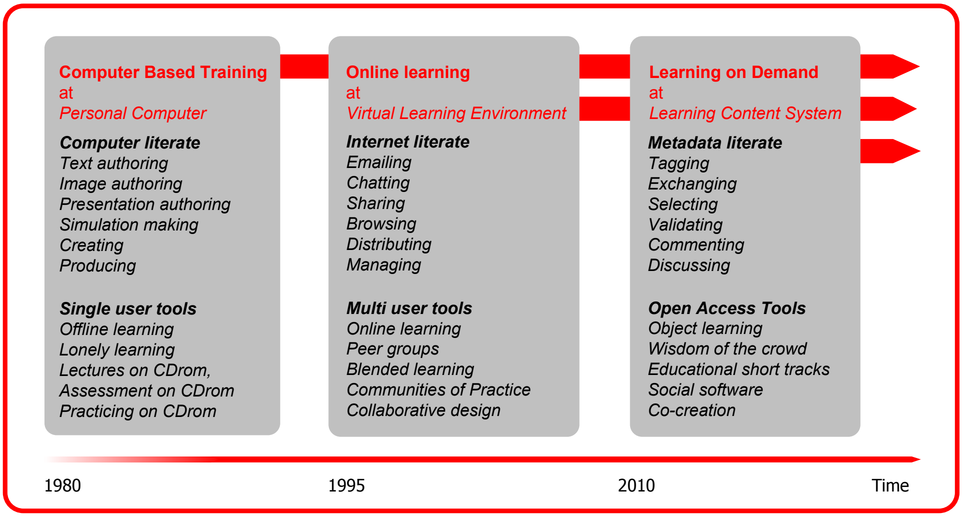


Figure 12: Timeline Overview of Educational Technologies and Practices by A.H.W. van der Zanden

If computer based training (CBT), online learning (OL) and learning on demand (LoD) practices are compared than quite typical characteristics can be discerned:
from personal texts on the local computer to communicating messages in emails to open texts stuck on public objects called tagging

- from creating electronic artefacts (text, image, etc) to sharing them with online communities to selecting when searching for them
- from training as lonely learner to online learning in blended settings to reflecting in group learning supported by social software
- from computer based control on isolated tasks to peer group reviews as assessment instrument to open valuation by the anonymous wisdom of the crowd
- from offline working to online collaboration to virtual disposition
- from solo-designing learning artefacts to discussing the delivered work to co-creation and presenting it in the open arena

Striking is that the practices are based on successive technologies, the latter technology cannot be operating without the former technology when applied in their proper form. The different technologies with their related practices are shown in Figure 13 as building blocks for every stage. The personal computer (PC) as client system at the first level connects to the virtual learning environment (VLE) on the network at the second level. The VLE on its turn connects to the learning content management system (LCMS) at the third level.

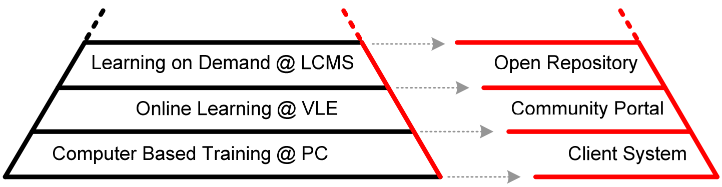


Figure 13: Stages of Successive Information Technologies to support ICT Enhanced Learning Practices by A.H.W. van der Zanden

A second ICT-chain, rapidly growing next to the formal PC-VLE-LCMS chain, is where a client system, such as PC, mobile phone, personal assistant and electronic pad, connects the first level to the second. On the second level are the social software portals, on their turn, these portals are connected to repositories at the third level, holding increasingly learning materials as open access artefacts. How such transformation from the left formal chain to the more open chain takes place in not clear, but the movement certainly has begun.

q. ***We wondered how open access artefacts, as free learning materials for everybody, will influence the university's position.***

3.5 Relevant Educational Technology Literacies

The educational practices of computer based training, online learning and learning on demand were described in Section 3.4. Dependent on the practice, corresponding features and tools are available that shaped its uses. The ability to handle such tools is caught by the word 'literacy'. Literacy is defined as knowledge of a particular subject or particular type of knowledge (Cambridge University Press, 2001), for educational practices, the necessary skills to operate and exploit the practices. Teachers and students use corresponding tools and learn to apply them in several settings. According to DeSanctis such learning-to-use-tools make it possible to apply a steadily deeper level of possible functionalities using the tool (DeSanctis & Poole, 1994). The structuration and appropriation processes do their work, in the end tool-using within a practice is considered normal. Moreover, it counts as one of the must-have skills to do a job whether designing, calculating, doing homework, assignments, or other tasks.

Today, we consider it normal for everyone to know how to operate a computer, to move a mouse, to type keys on a keypad or keyboard, to operate a calculator, or work with text editors, design tools, e-mailing, web-surfing, and so forth, all of which depend on the place to be and the task to do. This is in contrast with the 1980s, when the personal computer came to the classroom and movements were set in place to promote teachers getting their international computer driving license (ICDL), huge discussions took place, teachers were obliged to learn computer skills, such as text editing, spreadsheet calculation and PowerPoint presentation; screen reading, keyboard typing and mouse movement skills formed the most basic elements of these skills.

Due to this computer literacy movement, information technology programmes began at schools and universities, pupils and students learned theory and practice in the classroom, at home they really became used to operating the PC. Automatically they grew into *digital natives* as Prensky calls them (Prensky, 2001). Parents and people outside the school with no need to use the PC remained computer illiterate. Some of them, who wanted to catch up, followed courses to gain appropriate computer skills, they became *digital immigrants* (Prensky, 2001). People in offices and researchers caught up the computer skills revolution but they learned them at work (OECD, 2000). Governments promoted the use of PCs at home, often subsidising private computers for the home. Over the years discussions about gaining mandatory computer skills for every citizen continued, the 'Digital Divide' came into being (Compaine, 2001). In due time such discussions will fade because of the penetration of IT technology into every corner of Western society. Today's youngsters do not know a world without the computer (Veen & Vrakking, 2006).

Over time, multiple educational technologies have come and will come into existence within higher education. Every technology carries its own handling and features. We are able to discern some typical user characteristics for the several systems. As a result, we can catch such typical uses under the term literacy, but they will be called after corresponding educational technologies. In order to discern the literacies for several educational practices, we focussed on general skills that are typically needed to operate the main IT tools. We arbitrarily chose to discern six cognitive skills to represent a practice, these are discussed below.

3.5.1 Computer Literate

text authoring
image authoring
presentating
simulating
creating
producing

The skills required to operate the PC are *authoring of texts*, *of images*, and *of presentations* for the computer based training practice. The PC is especially suitable to design and build virtual objects and a strong tool for *simulation*. It is the tool for *creating* and *producing* such objects. Using these six skills, the most and typical things-to-do with a PC are covered. We have not covered the motor skills required to operate a mouse and keyboard because we consider them intrinsic to the PC user. The list of skills was arbitrarily derived from the International Computer Driving License Foundation website www.icdl.com and from literature in general (Veen & Jacobs, 2005), however, no statistics were executed to reveal or to check the validity of the six skills. They are seen as typical and open for discussion. When the PC finally took its place as a stand-alone tool in the classroom developments using the computer continued. All sorts of subsidy arrangements were rolled out by governments and institutions to stimulate people to obtain and to use a PC at home.

Summarising we want to say that the six skills, text authoring, image authoring, presentating, simulating, creating and producing, are those typically needed to operate a computer. Although these skills were critical two decades ago, they now begin to loose their relevance as many of us acquire them by playing from early childhood on. Nevertheless, these are basic skills that need to be included in any future design of learning systems.

3.5.2 Internet Literate

emailing
chatting
sharing
browsing
distributing
managing

At the end of the 1980s, the local area networks (LAN) began to be used, these were transformed into the Internet in the early nineties. Online communication such as *emailing* and *chatting* became popular with the diffusion of networks. In addition, resources connected to the network became easy to share. In the beginning, these were file and print services and over the years information resources and other virtual objects came online on the Internet and the Extranet. *Sharing* was the way to make these virtual objects available and *browsing* became a significant skill supported by the early graphical web crawlers such as Netscape and Mosaic. Commercial and military institutes built supportive technologies to manage online courses and underlying administration. This grew to the practice of online learning as we know today. The great benefit of the virtual learning environment (VLE) was the one-stop-shop for online materials. *Distributing* became an easy way to manage subject matter for both the teacher and student. Moreover, *managing* courses online within a VLE is efficient and easy if one considers messaging from one-to-many, one-stop for learning outcomes, concentrated hyperlinks for references, online readers and general course information.

Summarising we believe the following six skills are necessary before someone can learn effectively online: emailing, chatting, sharing, browsing, distributing and managing.

3.5.3 Metadata Literate

exchanging
tagging
selecting
validating
commenting
discussing

The next generation educational technology will be based on software portals and object repositories. Communication and sharing will be the habits of the emerging learning-on-demand practice. People will be able to communicate in a more natural way supported by the evolving technologies, content will be more open and valid. Repositories as carriers of virtual knowledge objects and resource locations will consists of increasingly validated objects and learning objects as stand-alone materials or parts of learning tracks. Today's libraries and universities are working hard to set these processes in motion. Each repository or distributed group of repositories will contain materials relevant to certain specific domains or expertises.

Societal developments have led us to a world where many people are able to be online on a continuing basis. An important human characteristic that shapes these developments is the desired exchange of information. This is shaping these evolving hybrid environments of man and machine. We call this *exchanging*. Exchanging is more than sharing, it is like trading, people put virtual objects into communities to make use of online packages of that community containing virtual materials and human advice. Social behaviour built on social software, better known as Web 2.0, has caused a need to tag information to allow it to be collected as metadata for the exchange of virtual objects. We call this *tagging*. Simultaneously *selecting* and *validating* skills have become important for the sorts of objects guided by tags. Consequently, if one is *commenting* on such virtual objects than one must be able to assess the value of such objects to be in tune with other community members. As a result, *discussing* has become a vital skill in the exchange process. Mutual discussions between peer members of a community are stored in a portal's underlying blog system, to form the online memory or knowledge body for a community.

Summarising we believe the following six skills are essential for the learning-on-demand practice: exchanging, tagging, selecting, validating, commenting and discussing.

3.5.4 Concluding Remarks

One has to learn the appropriate skills to handle educational technologies. In addition, one needs to adopt given technological functionalities into one's work. Education as such has been enriched with pedagogies that benefitted from the information and communication technologies. The classroom setting has been strengthened with computer based training and online learning in blended situations, these are common practices today. In the last few years, social software applications have become more powerful within education. Communication has become increasingly important. Many discussions are taking place amongst educationalists regarding the new pedagogies grounded on collaborative learning and group working.
Social software applications and repository systems are a response to the need to support successive learning on demand educational practices, and these evolving technologies on their turn support for additional changes in pedagogies. Lectures, as the all time teaching strategy, are increasingly being exchanged for settings that support appropriate collaborative learning and group work, especially in project-based settings and authentic situations.

We have focussed on institutional technologies, systems that have been or will be institutionalised. Other interesting developments aim at new learning practices, such as serious games (Egenfeldt-Nielsen, 2006; Gibson et al., 2006; Kebritchi & Hirume, 2008; Wolf & Perron, 2003), which will create needs for specific playful skills to handle them, offline and online. The services, storage and facilities of these serious games will follow the mentioned institutionalised educational technologies, however, the appropriate educational practices might be shared under computer based training, with additional game literacies, because of the dedicated client technologies (Egenfeldt-Nielsen, 2005; Gee, 2003).

We will now discuss teaching, educators argue that teaching is slowly shifting from providing instructive directions to self-supported collaborative learning strategies (Carneiro, 2007). That shift give rise to a need for additional learning spaces, such as collaboration spaces and learning centres (Oblinger, 2006). Together with personalisation of learning within education, in response to minor and major structures in the curriculum, there is a need for many smaller classrooms to accommodate these specialised sessions. Despite such shifts from instruction to self-regulated learning, some forms of teaching are there to stay, students need teachers to give them directions, give them feedback and to answer questions. Moreover, as new ways of teaching and learning emerge students need help, someone who will encourage them and stimulate them. This is certainly in an educational world that is growing ever more inter-disciplinary in nature, and where appropriate communication skills are necessary to instruct and for the learner to learn.

r. We wondered if Internet literacies, supposed to be related to online learning, can be recognised in the VLE uses.

3.6 LEARNING THEORIES AND INSTRUCTIONAL DESIGN

The first chair of pedagogy started at the end of the 18th century in Germany but only since the 1920s the education research of instructional design became a serious issue globally. The definition of learning, and the way it occurs, has significant implications for the way the education system is facilitated. Many researchers have been posing as many educational practices, but one agrees that there are three main learning theories to distinguish, behaviourism, cognitivism and constructivism.

In this section a brief overview is given of these main learning theories, of instructional design, and of the first attempts for an upcoming learning theory, to indicate the continuous progress within the education research domain. The main theories are complex scientific interactions between psychologists, neurobiologists, sociologists and educationalists. This section gives an indication where one could apply such theories, however, because of the nature of learning there is not a one for all solution, it depends on the student's actual knowledge and the personal learning objective which approach may be followed.

3.6.1 Behaviourism

Behaviourism was very popular in the beginning of the 20th century and is based on the change of reflexive behaviour of a person or animal with the help of external stimuli (Skinner, 1947; Watson, 1913). Behaviouristic experiments are divided into two forms of what is called conditioning:

- With 'classical conditioning', for instance Ivan Pavlov trained his dog to drool with an unconditioned stimulus, such as food, and at the very same time a conditioned stimulus, such as a bell. When the dog got food it started to drool and the bell rang. After many repetitions of the experiment, in the end, only ringing the bell produces the dog to salivate on its sound. It then had become a conditioned response (Pavlov, 1927; Yerkes & Morgulis, 1909).
- With 'operant conditioning' certain behaviour is deliberately rewarded or reinforced with for instance positive feedback, with the consequence that the behaviour is repeated, which is reinforced again with another positive message, and so on (Skinner, 1950). With operant conditioning the learner has the opportunity to respond on the message in stead of only responding to an external stimulus of the environment. The reinforcer can be anything that strengthens the desired response, such as a compliment or pat on the back. The theory also covers negative reinforcers such as punishment, which have to result in reduced responses.

The learning goal of behaviourism aims at automating certain actions due to repetition and external stimuli. Practicing and training are the keywords just until automatic execution is taking over without any thinking. It is not only for the mind but also for motor movements. Examples are solving a math problem, applying mechanical formulae, hitting a ball, taking a penalty, driving a car, or even the training in a flight simulator.

Behaviourism tries to explain learning without referring to mental processes. It refers in general to low-level learning experiments focusing largely on reflexes by 'drill and practice' and 'instructional cues'.

3.6.2 Cognitivism

Cognitivism was very popular in the middle of the 20th century and is based on exploring the mind while observing the change of the outside behaviour. Many theorists such as Piaget, Vygotsky, and Gagné disagreed with behaviourism because they were convinced that learning could also occur without external stimuli (Gagné et al., 2004; Piaget & Inhelder, 1969). According to their vision the human mind is an input – output model of information. They argued that if learners can apply certain rules, concepts and knowledge, of for instance procedural steps in different scenarios than the transfer of such knowledge has occurred.

Cognitivists refer to the mental processes while external stimuli trigger the learners' behaviour. The change in action is observed and measured by what the learner knows and not by what the learner does. The observation is fed back to the learner, so that he or she knows about the progression. Especially CBT is based on cognitivism with for instance the training or a course installed on the computer. At first CDRom software and later Internet courses were exploited and distributed by many training institutes (Alessi & Trollip, 1991; Dopper & Ven, 2001; Jones, 2002; Lowyck, 2001; Spector, 2001; Steeples & Jones, 2001).

3.6.3 Constructivism

Constructivism became very popular since the 1960s and is based on the premises that a learner actively constructs his or her own understanding through reflection on individual experiences. Knowledge is not transferred from one individual to another but the learner orchestrates, selects, transforms information, constructs hypotheses and makes decisions to construct knowledge in the own way with own rules and own mental models. Constructivists understand knowledge as something internally in the mind constructed by each individual meaning that every individual may interpret the same colours in different ways, the same shapes in different ways and the same structures in different ways. How exactly the construction is taking place is still not known, but when knowledge is transferred from teacher to learner than always some sort of translation does occur. Immanuel Kant calls such translation the transcendental process (Kant, 1787).

Jerome Bruner with his 'theory of instruction' argues that the task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding (Bruner, 2004). It should address four major aspects:

- predisposition towards learning
- structured in a way that it can be easily grasped by the learner
- sequenced in the most effective way to present its materials
- natural pacing of rewards and punishments

Constructivism is accepted to apply for education practices with cognitive harder subjects. Social constructivism as an additional form is applied for assignments to groups of students where problem solving is done over for instance different disciplines in which constructs are built together and reflected with peers (Smith, 2002).

3.6.4 Remarks

Peggy Ertmer and Timothy Newby have compared the three main learning theories on multiple characteristics such as how the learning occurs, which factors influence the learning, what types of learning are best explained by the theory, and how the instruction should be structured for facilitating the learning (Ertmer & Newby, 1993). In Figure 14 a summarising overview is presented for behaviourism, cognitivism and constructivism with their typical characteristics.

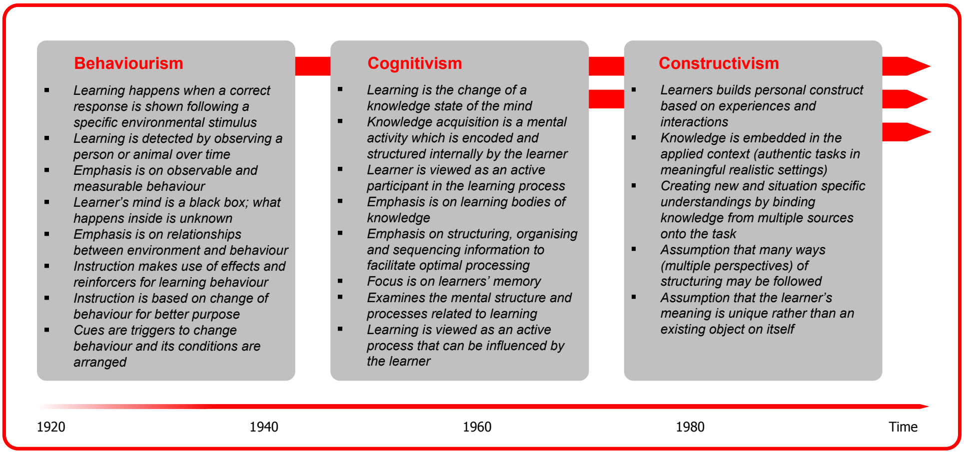


Figure 14: Timeline Overview of main Learning Theories with their Characteristics (I. Ipek, 2007)

Knowledge can be obtained in many different ways, such as observing, looking, listening, sensing, joining, doing, training and communicating. Each way lets you learn something, but what the best way is to follow depends on the learning objective. Learning objectives can easily vary from getting an overview to fully understand a principle to produce something without hesitation.

Because learning is influenced by many factors from many sources, the learning process is constantly changing, both in nature and diversity (Shuell, 1990). What might be most effective for novice learners when encountering a complex body of knowledge for the first time, would not be effective, efficient or stimulating for a learner who is more familiar with the content. It must be considered that learners acquire more experience with certain content; they progress along a low-to-high knowledge continuum (Ertmer & Newby, 1993):

- from being able to recognise and apply the standard rules, facts and operations of a profession (knowing what)
- to thinking like a professional to extrapolate from general rules to particular, problematic cases (knowing how)
- to developing and testing new forms of understanding and actions when familiar categories and ways of thinking fail (reflection in action)

The instructional designers must consider what is the best theory to master specific tasks by specific learners. For instance mastery of the content of a profession is best done with a behavioural approach, cognitive strategies are useful in teaching problem-solving tactics where defined facts and rules are applied, and the constructivist strategy is best suited for ill-defined problems. In Figure 15 Ertmer and Newby set out the "learners' level of knowledge" and "cognitive processing demands" as two continua along the axes. The figure illustrates when a certain learning theory or strategy appears applicable. The figure is useful in:

- demonstrating that strategies overlap, for instance one strategy may be relevant for each of the different perspectives, given the proper amount of prior knowledge and the corresponding amount of cognitive processing.
- demonstrating that strategies are concentrated along different points of the continua due to the unique focus of each of the learning theories.

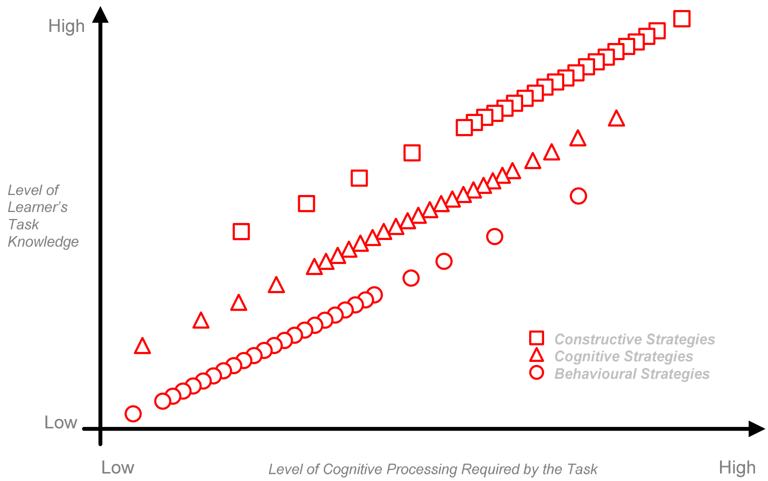


Figure 15: Comparison of associated Instructional Strategies of Behavioural, Cognitive and Constructivist Viewpoints based on Learner's Level of Task Knowledge and Level of Cognitive Processing required by the Task (Ertmer & Newby, 1993)

In fact, successful instructional practices have features that are supported by virtually all three perspectives. Such indicates that people with a lower degree of knowledge can fulfil an academic task, but they probably will take a while longer, dependent on their experience on the task and level of prior knowledge. Instructors have to consider what the best theory is to master specific tasks. According to Figure 15, it is obvious that academic challenges should follow a constructivists' approach.

3.6.5 Instructional Design

Instructional Design is the systematic process of designing, developing, evaluating and managing the entire instructional process to ensure effective and efficient learning. It is based on what we know about instructional and learning theories, systems design, information systems and management (Morrison et al., 2006).

Two major categories of learning theories that have influenced the instructional design procedures and decisions are the behavioural and cognitive learning theories. However, learning theories themselves do not offer guidance in how to teach. We need instructional-design theories to identify useful methods for particular situations. In contrast to learning theories, instructional-design theories are more directly and easily applied to educational problems. They describe the specific events in the environment or methods of instruction that are outside the learner. Many instructional design models are briefly mentioned in this short overview (Leigh, 1998; Masters, 1995), many sorts of disciplines have added their part to the learning theories. Since the beginning of the 20th century, many intelligent people conducted research activities and put forward publications to alter views of learning.

At the turn of the 20th century John Dewey argued that learning occurs best when 'doing the thing' rather than 'learning the facts of the thing' by heart (Dewey & McDermott, 1981). From the 1920s on the behaviourist approach to educational psychology became increasingly dominant and with the Second World War a tremendous instructional program was worked out for rapidly training the hundreds of thousands of military personnel. Creating standardised methods for instruction using training films and other mediated materials for instructional purposes. Ralph Tyler's work, a decade earlier, indicated that objectives were most useful to instructional developers if written in terms of desired learner behaviours (Tyler, 1976).
The 1950's were characterised by the formulation of theoretical models of learning. In 1956, Benjamin Bloom's taxonomy of intellectual behaviours provided instructors with a means how to teach instructional content to learners most effectively (Bloom, 1956). The six levels of intellectual behaviours are 1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5) Synthesis, and 6) Evaluation. Combined with Bloom's Taxonomy, the systems approach to instructional and organisational development allowed planners and policy-makers to match content and delivery of instruction in a fashion which considered both super- and sub-systems (the organisation as a whole, as well as groups and individuals within the organisation).
In 1957 the Soviet Union launched the Sputnik satellite and started the famous 'Space Race'. The America government was forced to re-evaluate the education system and its shortcomings. Science and math programs were the first to be targeted, and the government employed experts in these fields to bring the content up to date. The emphases on development of instructional programs were focused to the design of the entire curriculum.
In 1962 Robert Glaser synthesised the work of previous researchers and introduced the concept of 'instructional design', submitting a model which links learner analysis to the design and the development of instruction that followed a more cognitivist approach. His model led to the Individually Prescribed Instruction (IPI) approach whereby the results of a learner's placement test were used to plan learner-specific instruction (Glaser, 1962, 2000). At the same time Robert Mager published his treatise on the construction of performance objectives. He suggested that an objective should be described in measurable terms when a person works on achieving the objectives, the behaviour, the conditions or limitations under which they must carry out this behaviour, and the criteria against which the behaviour would be compared (Mager, 1997).
In 1962, Robert Gagné published his "Military Training and Principles of Learning" which demonstrated a concern for the different levels of learning. His differentiation of psychomotor skills, verbal information, intellectual skills, cognitive strategies and attitudes, was providing a companion to Bloom's six cognitive

domains of learning (Gagné, 1962). Later, Gagné extended his thinking to include nine instructional events that detail the conditions necessary for learning to occur, which are 1) Gain attention, 2) Inform learners of objectives, 3) Stimulate recall of prior learning, 4) Present the content, 5) Provide learning guidance, 6) Elicit performance, 7) Provide feedback, 8) Assess performance, and 9) Enhance retention and Transfer to the job (Gagné et al., 2004). These events have been used long since for the design of instruction and selection of appropriate media (Laurillard, 2002).

The mediation of instruction entered the computer age in the 1960s when Patrick Suppes conducted his initial investigations into computer assisted instruction (CAI) at Stanford University (Suppes, 1972). CAI provided learner feedback, branching and response tracking, which later were incorporated into the PLATO system in the 1970s and still are guidelines of today's instructional software.
A variety of models for instructional system design (ISD) did spread since the end of the 1970s to date: Atkins, Branson, Dick & Carey, Gagné & Briggs, Gustafson & Branch, Kemp, Morrison & Ross, Leshin, Merrienboer, Merrill, Pollock, Reigeluth, Seels & Glasgow, Smith & Ragan, to name a few. One possible reason for this phenomenon deals with the establishment of formal education and training departments within both public and private organisations. Faced with the computerised technologies at the times, the organisations required a means to quickly develop appropriate methods to educate internal employees in new business practices, which came up because of the information age. Another explanation is that businesses, especially consulting organisations, become increasingly required to demonstrate value-adding, not only to their organisation but to the clients they serve (Leigh, 1998).

3.6.6 Connectivism

One important missing issue in the main theories Behaviourism, Cognitivism and Constructivism is that none of them considered the educational technologies. That sounds obvious because only in the last four decades ICT was brought into the classrooms and the main theories were developed long before the introduction of ICT, but what strikes is that the main theories seem to thrive by it just as a result of the use of these educational technologies.
When considering the educational technologies there are new ways of learning possible which are mainly or sometimes even only possible with such ICT. One can think of electronic communication patterns both synchronous and asynchronous, electronic reflection and peer review process, virtual simulation of practical and non-practical situations, massive multiplayer online role playing games (MMORPG) to imitate situations, instant online search, instant translation, instant help, electronic portfolio, etcetera. Such ways of learning are not considered with the main theories, hence, a new movement is upcoming called 'Connectivism'.

Connectivism is becoming very popular since about 2005. George Siemens as author of "Connectivism: A learning Theory for the Digital Age" suggests the new learning theory, but now mostly based on ICT as intrinsic learning principles. Siemens argues that our brains are changed and are even formed by technologies, our behaviour is shaped through the uses of technologies (Siemens, 2005).
Know-how and know-what is supplemented with know-where as the understanding of where to find the knowledge needed. Siemens argues that behaviourism, cognitivism and constructivism do not address the learning outside the person, this is knowledge stored in databases or other electronic information holders that are accessible through the Internet. The learning theories also do not address learning as it occurs within organisations but between people such as organisational learning and informal learning. The most intriguing one is that the theories are not valuing knowledge as such, the worthiness of rapid action is a valuable skill for collecting the right knowledge in the ever-growing amount of information through synthesising and recognising patterns, especially today where the scarcity of information and communication diminish and information skills such as recognising and selecting, become valuable competencies. The 'meaning making' and 'forming connections' between specialised communities are important activities in the information age (Siemens, 2005).

3.6.7 Conclusion

Learning in the information age is done through networks, both human and electronic. Undergoing individual or lonely courses and training sessions with CBT were taken over by VLE's with communication

possibilities. Today, with repositories, specific learning materials are searched for instantly to meet a sudden question to solve, in stead of following complete courses or lectures in the hope that the topic comes by.
Electronic communication amongst persons and systems becomes popular, hence, learning on virtual networks takes surprisingly innovative forms, learning becomes aggregating and associating, learning materials appear disordered and concentrated. Virtual learning often happens outside the classroom, far from formal ways of education, which sometimes leads to unwanted developments, such as not addressing the validation of such learning materials. Free learning without its necessary correction when wrongly learned is an unwanted phenomenon. The watching eye of an instructor or coach remains necessary, for instance, when learning materials contain flaws or are incomplete, than the learner easily takes in wrong methods or facts. Dirk Tempelaar's research addresses such flaws between what he calls 'naïve learning' and 'formal learning' (Tempelaar, 2007). The positive development is that in such behaviour learning becomes a way of life, which perfectly fits the life-long-learning paradigm.

The future student is a networker who is used to consult information on the Internet. Using the help of online social networks he or she looks up instantly what is needed just-in-time. The future networker must be able to judge the validity of online information and must be able to come up with creative and innovative solutions. Three sorts of networks for such networked learning are distinguished (Veen & Jacobs, 2005):

- interpersonal networks both online and offline
- neural networks (the brains) which hold our own constructs and mental maps (CERI, 2007)
- technological networks for online communication, information bases, research bases, and libraries (Rowley et al., 1998)

More valid and true scientific information is coming online, well supported by the Open Education Resources (OER) movement, hence, the process of learning will take a firm place next to the learning content itself. Online content may be understood as external memory as we consider youngsters who rely completely on their electronic extensions for looking up small facts (Quinn, 2007).

To conclude this section of learning theories we may consider that in the last century many views from several disciplines were published representing learning modes that were sometimes radically different than the ones executed in the classroom. However, since the last four decades many publications indicated new educational practices, which were built on information technologies, but all conclusions constantly repeated the same sorts of results (Laurillard, 2002). It is time to build a new body of knowledge, for the time being catched under the term Connectivism (Siemens, 2005). The time has come to permanently introduce an educational practice, which considers formal and informal learning situations and is enhanced maximally with information and communication technologies to meet the current pressures on higher education.

s. We wondered which educational practice can facilitate formal and informal learning situations maximally enhanced with ICT technologies.

3.7 CLASSIFYING KNOWLEDGE

Knowledge Management, as a symptom of the information economy, needs to be seen in the context of a shift that has been taken place in learning. Up to the 1970s, people had to 'learn to work', they learned a trade or profession and went to work, confident of a job for life. Later on they began to 'learn at work', updating their knowledge through continuous learning. In the 1990s, the shift was to 'learn through work', with the emphasis on building and proving a series of competencies. In the twenty-first century the trend is 'learning is work' (OECD, 2000); conventionally produced training modules will become obsolete, they will be replaced with knowledge management mechanisms, in institutions large and small, that allow instant updating of knowledge and its constant evolution (Prometeus, 2001).

The word *'knowledge'* is used for many purposes in our information economy. Terms such as facts and competences, insight and routine, implicit and explicit knowledge, and so on, are commonly used when describing knowledge and its types. We would like to follow the classical definitions of the Greek philosophers Plato and Aristotle to describe and catch the different forms of knowledge. The Greek philosophers explicitly make a distinction in 'true knowledge' and 'assumed knowledge' (Aristoteles, 2005; Capurro, 2004), and these same distinctions can be adapted to our times with examples added to help us make the right distinction. This will allow us to assign appropriate learning practices and educational technologies.

3.7.1 Episteme (επιστημη)

Episteme is cognitive knowledge, based on valid scientific information, such as facts, numbers and formulas. Episteme is permanent and unchangeable, at point of use, though further developments may change things. It is the knowledge taught at school and passed on to the next generation. Valid information is rough data but it must be understood within its context, thus episteme is an active process of knowing, allthough the facts, figures and formulas alone give no meaning. Episteme is to compare with 'know-that' (Aristoteles, 2005; Capurro, 2004; Masters, 1995).

- Such defined, determined, validated and described knowledge, which once was to be learned by heart, is increasingly accessible on the Internet or in virtual libraries (Rowley et al., 1998). Now such information is so easily found that it is no longer necessary to learn it by heart; as long as one can understand the concepts where such knowledge is applied, and one can obtain relevant knowledge from databases or other systems. Such systems can be seen as external memory.
- Today, young students adopt a communicative attitude, which fits with the way to get data when needed. Maybe such attitude is acquired because they possess all sorts of tools or technologies or maybe their attitude is second nature, because they have grown up with the phone, the mouse, the calculator and the computer. In either way the youngsters consider their tools to be normal extensions of their bodies and personalities (Veen & Vrakking, 2006), but even more as external memories used to store all sorts of simple facts, such as phone numbers, addresses and 'to do's' (Quinn, 2007). Prensky calls such youngsters 'digital natives' because they develop their intrinsic computer skills (Prensky, 2001; Tapscott, 1997). 'Digital immigrants' are those of us who learned the skills required to use modern information and communication technology at a later age, unfortunately, the immigrants will never be as good as the natives. Using the metaphor of the Olympic ski champion will help us to explain this a little further: ski champions are almost always people who have been raised in the mountains where it snows on a regularly basis, and where ski slopes can be found. They climb, feel, practice, smell, fall, and, being attracted to skiing when they have the opportunity. It is a rare ski champion who was born in a flat land. Such mountain people can be termed ski natives which will make the flatlanders ski immigrants.
- Connectivism as an upcoming learning theory supports such process-oriented knowledge-based acquisition on network learning behaviour. Students connect to persons and systems, thus treating them equally as virtual extensions, and use them for instant knowledge-on-demand when needed.
- Almost every domain, from mono-disciplines to complex multidisciplinary projects, has its own episteme, its own facts and figures. This supports 'knowledge-object-bases' that are easily realised for online support, for distance learning and for open courseware initiatives. New applied technologies

such as social software portals and learning content management systems with their underlying repositories exactly fulfil such connectivist's epistemological needs.

3.7.2 Techne (τεχνη)

Techne is craftsmanship or workmanship. It is the skill of technical insight, motoric skills, craft or art of knowing how things work and how to repoduce them. Things such as systems, models, methods and techniques used, dependent on the technical profession of the user. It is the action of producing an object. Techne is probably better called 'know-how' (Aristoteles, 2005; Capurro, 2004; Masters, 1995).

- Techne is where engineers or artists are the champions. They excel in 'white box' thinking, they know what is inside, how things interact or operate, how they interchange or are mixed. For example someone can produce a cup, a process they know by heart, that fit for purpose, and they can reproduce this skill, this is called routine. Techne is used to calculate its strength, will the handle hold, it is the knowledge of its characteristics i.e. of the joint handle to body of cup, and the knowledge of which materials should be used in what environment. One is sure the construction is good and the right sort and amount of materials has been used, rather than underestimating a materials' strength for that usage.
- The younger generation generally are 'black box' users, they think technology is obvious or natural; it is just there to be used as a consumable (Siemens, 2005). Older generations constructed their own toys out of wood, using mechanic tools or Lego, they joined hobby clubs where all the senses were used to create dolls, train scapes, repair bikes and cars, sew dresses and so on. Today, it seems normal that others, such as a parent or older friend, repair the flat tyre or replace it with a new one, install the computer and replace it with new ones on a regular basis, help with homework, or name a website where one can find answers. The younger generation is able to negotiate and manage things without dirtying their hands (Prensky, 2001). They take their friend's bicycle when they need one instead of repairing their own. They borrow tools from those who can use them, use them badly and forget to return them. Today youngsters have the attitude, that they will only spend energy when absolutely necessary, and then mostly for something they like to do (Tapscott, 1997). Ownership of material things is becoming less personal, things belong to the group, family, friends, or peers. We are entering a fully-fledged consumer society with use of tools such as mobiles, cameras, electronic cards and computers (Nolan, 2000).

3.7.3 Phronesis (φρονησις)

Phronesis is the skill of practical insight coupled with an ability to act and think morally. It is the mastery to apply something and to know and feel that the product will be good and not bad. Phronesis is a practical thing, it is a doing action on a basis of moral considerations. Phronesis is probably better called 'know-why' (Aristoteles, 2005; Capurro, 2004; Masters, 1995).

- Phronesis grows by doing and learning and practicing and repeating the things in different situations. One does not learn this skill from a book but rather by experience. As a simple metaphor, take a book about swimming, one can learn the text about swimming techniques by heart, one can be lectured about swimming in many ways, but only when one enters the water and experiences its wetness, buoyancy, currents, and when one begins to try to move effectively in the water, one can learn to swim. Becoming a competent swimmer takes time and practice in a variety of water related situations. Swimming and obtaining the practice skills to swim well, is a good example of phronesis. Phronesis is not routine, because with routine one does not think anymore, use the skill unconscious, some sort of automatic behaviour, with phronesis, however, one also knows why and how one uses a skill. One also has considered the consequences of using a skill for people and the environment.
- Phronesis is a typical characteristic of the academicly educated, they use knowledge to create and assess things for practical or scientific purposes and to meet societal needs. Ethics is an essential skill in the information age where economics thrives on valorisation.

3.7.4 Nous (νους)

Nous is the intellect, scientific reasoning, logical derivation separated from the senses. Nous is the elaboration on earlier obtained knowledge (Aristoteles, 2005). It is about thinking inductively, deductively and abductively.

- Using nous you can think about cause – effect relationships and to what consequences some actions will lead. Nous is becoming a very important communication skill in the information age. Using Nous two or more disciplines may collaborate to work out a concept or design, however, they have to adjust their methodologies and techniques to fit. All too often learned skills and knowledge are taken for granted and discrepancies only show themselves at the end of a product line. A lack of nous can be demonstrated in accidents that are caused by human errors. For example, due to a failure to note differences in dimensions and parameters, such as using degrees Centigrade in one discipline and Fahrenheit in another, or centimeters being confused with inches, which caused the lost of the Mars Climate Observer (Oberg, 1999). More hidden discrepancies come from vocabularies where the same word carries different nuances or meanings in different disciplines. Discrepancies also occur as the result of deviated design approaches.
- One must be open-minded and educated to cope with inter-domain adjustment and interfacing: design methodologies, fabrication techniques, technologies, dimensions, vocabularies, ontologies and product features must be taken into account when multiple disciplines collaborate. It is striking that courses aimed at such inter-disciplinary communication are rarely taught in the current curricula.
- Proper inter-disciplinary communication requires us to master dialectics as thought, analysis and discussion, and rhetorics as instruction, persuasion and reasoning. Cognitivism and Connectivism seem proper pedagogical approaches to use to obtain Nous. Debating with peers and adversaries gives us possibilities for practicing and reflection, not for persuasion but for passing over and adjusting knowledge in an unambiguous way.
- Nous is better called 'know-between' representing interdisciplinary communication for adjustments between two or more mono-disciplines.

3.7.5 Sophia (σοφια)

Sophia is the competence to see the whole of things, how they relate to each other, and to assess the consequences when processes are triggered or changed. Sophia is the wisdom of handling and judgement (Aristoteles, 2005).

- The university expects that the graduate will be able to handle or make judgements within their subject domain but managerial, communicative, ethical and sometimes aesthetical skills must be taught to complete this knowledge manifold.
- The constructivist's approach seems to be a proper pedagogical method to obtain Sophia, it is very important for adjusting, interfacing and bridging multi-disciplines within scientific project-based assignments, to compose valid definitions, agreements and essays through group thinking, for collaborative and co-creating working teams and communication aimed at models in peer reflection (Katzy, 2004).
- Sophia and Nous strengthen each other when multi-disciplinary challenges occur. Sophia stands for wisdom and for overseeing the whole of things, not limited to interdisciplinary communication, but overall project outcomes in adjustment with political, economic, ethical, aesthetical and humanist surroundings, hence, we want to call it 'know-across'.

3.7.6 Know-where

Aristoteles did not discern the 'know-where' knowledge, nor have researchers working on behaviourism, cognitivism and constructivism. Know-where became apparent when ICT was brought into learning practices and students were allowed to look for resources online, it refers to information skills such as understanding where to find the knowledge needed and how to assess resources on their validity, to synthesise multiple sources and to recognise patterns.

- George Siemens argues that the worthiness of rapid action is a valuable skill for collecting the right knowledge in the ever-growing amount of information (Siemens, 2005).

3.7.7 Hypolepsei (υποληψει)

Hypolepsei or hypothesis is conjectural knowledge such as a supposition or assumption, which has not been tested on its truth or its merits. It may be the start of a doctoral research, or it can be something on a smaller scale, such as master or bachelor studies, advisory reports or even small-scale studies.

- In a research study, for instance, the work can be done by falsificating a certain assumption. The more often falsification fails the better the assumption and the better the truth is approached. With another research assignment it is the acknowledgement of a starting hypothesis by collecting evidence on the assumption that the starting hypothesis is valid, sometimes it will be shown to be invalid.
- A doctoral thesis in the Netherlands normally comes with around ten propositions. Propositions are theorems, which coincide with the conducted research, but are not thoroughly falsified. Such propositions need to be verifiable, purposeful and challengeable.

3.7.8 Doxa (δοξα)

Doxa are views, opinions or judgements made by someone about a person, animal or thing (Aristoteles, 2005). The opinion does not have to be verifiable.

- Sometimes doxa leads to dangerous situations when, for instance, propaganda messages are spread. Repeating the same messages with a shaping purpose will cause it to find a place into someone's head, and they may eventually, treat or even recognise it as truth. When many individuals start to believe and form corroborating communities than great movements or even revolutions can chase standing situations. Sometimes for the better, such as the enlightenment to free the people from ancient regimes, and sometimes for the worse, such as anti-semitism during the Second World War.
- With debating a person is challenged to defend a proposition. The opponent is challenged to attack the proponent with nothing but words. Such debating is an excellent means to improve dialectics and rhetorics.

3.7.9 Bloom's Taxonomy for Accumulating Levels of Knowledge

In the year 1956 Benjamin Bloom led a group of educational psychologists who proposed a classification of levels of intellectual behaviour that were important for learning, as depicted in Figure 16. The cognitive domain involves knowledge and the development of intellectual skills. At that time Bloom found that 95 % of the questions asked to students were about recalling information, which is using episteme knowledge. Bloom led a committee who also identified two other domains of learning next to 'Cognitive', i.e. mental skills, which are 'Affective', i.e. growth in feelings or emotional areas as is depicted in Figure 17, and 'Psychomotor', i.e. manual or physical skills as is depicted in Figure 18.

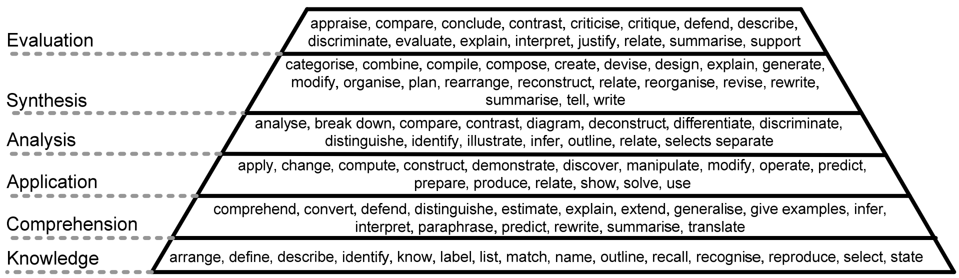


Figure 16: Bloom's Taxonomy of Learning with the Lower Cognitive Skills at the Bottom (Bloom, 1956)

According to Bloom the taxonomy of learning consists of six major categories, starting from the simplest behaviour to the most complex (Bloom, 1956). The categories are thought of as degrees of difficulties. That is, the first one must be mastered before the next one can take place. The divisions outlined are not absolutes and there are other systems or hierarchies that have been devised in the educational and training world. However, Bloom's taxonomy is easily to understand and is probably the most widely applied today. The hierarchy of learning is presented in Figure 16. It consists of six levels.

1. 'Knowledge' is recalling data or information from memory.

2. 'Comprehension' is understanding the meaning of instructions and problems such as rewriting a text or explaining in one's own words the steps required to perform a complex task.
3. 'Application' is using a concept in a new situation such as analysing a work situation or evaluation of different settings.
4. 'Analysis' is distinguishing between facts and interferences or separating materials or concepts into component parts, such as troubleshooting a piece of equipment or recognising logical fallacies in reasoning.
5. 'Synthesis' is building a structure or pattern from diverse elements, such as designing a machine to perform a certain task or integrating training from several sources to solve a problem.
6. 'Evaluation' is making judgements about the value of an idea or materials, such as selecting the most effective solution or explaining and justifying a new budget.

Affective includes the way we deal with things emotionally, such as feelings, values, appreciation, enthusiasm, motivation and attitude. The hierarchy of affective is presented (Krathwohl et al., 1999) in Figure 17. It consists of five levels.
1. 'Receiving' phenomena such as listening to others with respect and remember the names of newly introduced people.
2. 'Responding' to phenomena such as active participation in discussions, giving presentations, and questioning concepts and models in order to understand them.
3. 'Valuing' the worth to a particular object, phenomenon, or behaviour, such as beliefs in democratic systems, sensitivity towards individual and cultural differences and diversity.
4. 'Organising' values such as priorities by resolving conflicts between different values. The emphasis is on comparing, relating, synthesising values and the recognition of the need for balance between freedom and responsible behaviour.
5. 'Characterising' is showing confidence when working independently and acting as team member in group activities. Displaying a professional commitment to ethical practice and valuing people for what they are and not how they look.

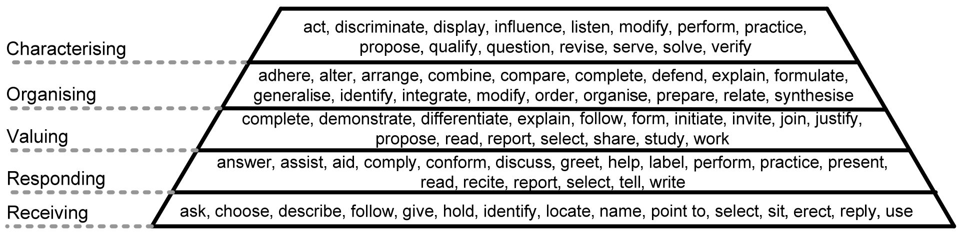


Figure 17: Bloom's Taxonomy of Affective showing the Hierarchy of Emotion (Krathwohl, Bloom, Masia ,1999)

The Bloom committee did not produce a compilation for the psychomotor domain model, but others have. The one presented here is by Simpson (1972). There are two other popular versions from R.H. Dave (Dave, 1975) and from Anita Harrow (Harrow, 1972). Psychomotor includes the way we deal with physical movement, coordination and our use of the motor skills area of the brain. Development of these skills requires practice and is measured in terms of speed, precision, distance, procedures or techniques in execution. The hierarchy of psychomotor according to Simpson is shown in Figure 18. It consists of seven levels.
1. 'Perception' is the ability to use sensory cues to guide motor activity, for instance to estimate where a ball will land after it is thrown and then moving to the correct location the catch the ball.
2. 'Readiness' to predetermine a person's response to different situations. Knowing a sequence of steps in a manufacturing process or recognising one's abilities and limitations.
3. 'Guided Response' is adequacy of performance achieved by practicing. To follow instructions or to build a model.

4. ‘Mechanism’ is the learned responses, which have became habitual. The movements can be performed with some confidence and proficiency for instance to drive a car.
5. ‘Overt Response’ includes performing without hesitation and automatic performance. To manoeuvre a car into a tight parallel parking spot or to operate a computer quickly and accurately.
6. ‘Adaptation’ is well developed skills to modify movement patterns to fit special requirements. To respond effectively to unexpected experiences or to modify instruction to meet the needs of the learners.
7. ‘Origination’ is creating a movement pattern to fit to a particular situation or specific problem. Learning outcomes emphasise creativity based upon highly developed skills. To construct a new theory or to develop new and comprehensive training programmes.

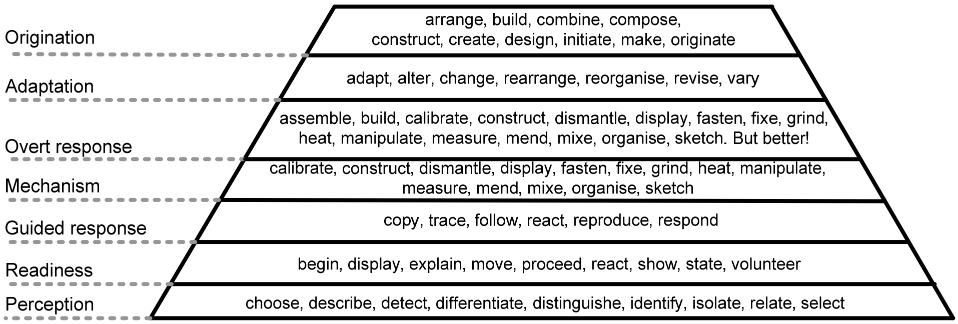


Figure 18: Simpson’s Taxonomy of Psychomotor including the Physical Movement, Coordination and Motor Skills (Simpson, 1972)

3.7.10 Concluding Remarks

The word *‘knowledge’* is regularly used in our daily work environment and literature, but the term knowledge is often applied in different ways for different situations. We have decomposed types of knowledge into six discernable classes. Know-how and know-why are in-depth types of knowledge of a domain, know-between and know-across are communication knowledge to interact between domains, know-that is epistemological knowledge about a domain, and know-where is to find the appropriate epistemological, product-oriented and process-oriented knowledge.

Bloom’s taxonomy of knowledge deals with elaboration with newer knowledge on built knowledge, or better put, accumulated knowledge. First, the lower level must be known before the next level can be mastered. Similar levels were introduced by the European Association for Education of Adults from the EHEA, which adopted the European Qualifications Framework (EQF) at the end of 2007. The EQF is a translation grid for qualifications obtained around Europe, it has two principle purposes: to promote student mobility between countries and to facilitate life-long-learning (Commission of the European Communities, 2005). The EQF contains eight consecutive levels of corresponding knowledge, skills and competences. These descriptors are used as standardised levels to compare international degrees and their qualities. Moreover, the descriptors are based on ‘learning outcomes’ and not on ‘learning inputs’ such as teaching institutes. The idea was that by the year 2010 every European education institute would refer to the EQF framework, which is presented in Table 7.

Table 7: Knowledge, Skills and Competences according to the Education Qualifications Framework (EQF)

Level	Knowledge In the context of EQF, knowledge is described as theoretical and/or factual.	Skill In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and use of methods, materials, tools,instruments).	Competence In the context of EQF, competence is described in terms of responsibility and autonomy.

1	*Basic general knowledge*	*Basic skills required to carry out simple tasks*	*Work or study under direct supervision in a structured context*
2	*Basic factual knowledge of a field of work or study*	*Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools.*	*Work or study under supervision with some autonomy*
3	*Knowledge of facts, principles, processes and general concepts, in a field of work or study.*	*A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information.*	*Take responsibility for completion of tasks in work or study.* *Adapt own behaviour to circumstances in solving problems.*
4	*Factual and theoretical knowledge in broad contexts within a field of work or study.*	*A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study.*	*Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change. Supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities.*
5	*Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of boundaries of that knowledge.*	*A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems.*	*Exercise management and supervision in contexts of work or study activities where there is unpredictable change.* *Review and develop performance of self and others.*
6	*Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles.*	*Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study.*	*Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts.* *Take responsibility for managing professional development of individuals and groups.*
7	*Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research.* *Critical awareness of knowledge issues in a field and at the interface between different fields.*	*Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields.*	*Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches.* *Take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.*
8	*Knowledge at the most advanced frontier of a field of work or study and at the interface between fields.*	*The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice.*	*Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research.*

The European qualification framework contains three tables with knowledge, skill and competence, respectively addressing Episteme or know-that, Techne or know-how, and Phronesis or know-why, but not the interdisciplinary skills of know-between and know-across, or know-where. Libraries have designed courses to teach information and validation skills, representing know-where, for the last five to ten years. Know-between and know-across have received little attention to date, however, there are courses that aim at dimensioning and ontologies. Know-between and know-across are communication knowledge, skills and competences that need to be taught by specialised inter-disciplinary instructors and learned by doing inter-disciplinary projects.

It seemed valid to set up a standardised education system to educate factory workers in the industrial age, because so many workers were needed on the work floor to work in similar conditions. It seemed logical to shape workers, as some sort of look-alikes considering their ways of work. When for instance in a factory the next shift came in to take over, the factory's work should roll on and continue without too much hesitation or trouble. The factory workers were more like drones with one or a few tasks who acted as extensions of the machineries (Marx, 1890). The education system of this time filled this need well to shape such blue-collar workers. Even the degree system supported such thoughts, an employer counted on the degree system to recruit new employees for a job based on work that matches that degree.
On schools a predetermined instructional package was delivered in a one-system-fits-all paradigm. Karl Marx and Friedrich Engels could not put it better with "*Die Arbeit der Proletarier hat durch die Ausdehnung der Maschinerie und die Teilung der Arbeit allen selbständigen Charakter und damit allen Reiz für die Arbeiter verloren. Er wird ein blosses Zubehör der Maschine, von dem nur der einfachste, eintönigste, am leichtesten erlernbare Handgriff verlangt wird*" (in English: Owing to the extensive use of machinery and to division of labour, the work of the proletarians has lost all individual character, and consequently, all charm for the workman. He becomes an appendage of the machine, and it is only the most simple, most monotonous, and most easily acquired knack, that is required of him) (Marx & Engels, 1848). The higher educated workers, called white-collar workers, designed work procedures for manufacturers and reduced them to simple instructions for the blue-collar workers. Changes in the process were handled according to formal procedural rules and because such changes occurred infrequently, everything was very well organised (Nolan & Croson, 1995).

Today the customer expects and deserves personal service. The industrial age factories are making place for service industries and customer-aimed production facilities. These service industries expect different skills from their personnel, not personnel who resemble the industrial workers but more like flex-workers, dynamic, pro-active and sharp, hence, the education of the coming workforce should be adapted to their working needs. The one-system-fits-all education system will cease to be viable.
Education, in general, is assembled out of many instruction parts and learning parts, where instruction is given and the learning is triggered. A degree system will not hold much longer and additional ways are being introduced to supplement graduate skills such as portfolio systems and degree supplements.

t. ***We wondered which university setting can address the discerned types of knowledge within the education practice.***

3.8 HIGHER EDUCATION IS UNDER PRESSURE INDEED

We have discussed many developments in this chapter that influence higher education. We have sketched influences and put overviews into historical perspective with the three university generations. Industrial developments developed in parallel with the second generation university where engineering education gained its important place in society. Research into educational practices started to develop in the 1920s and this brought about three main learning theories: behaviourism, cognitivism and constructivism. Information technology (IT) started to take its place as a supporting technology for all sorts of businesses since the 1960s onwards. Although IT has its own research area, its creative characteristics are only put to work in other professions. Information technology has taken its place in almost every domain penetrated by automation processes, from the financial ledger to industrial assembly lines. Automation has taken over repetitive tasks, within education, it is used to support educational processes. Information technology has excelled in places where the work is heavy, repetitive and lasting, such as in the automotive and process industries with automated mechanisms, especially robots, taking over assembly from humans.

Today, information technology is developing to a state where more intelligible tasks can be automated, such as communication support mechanisms from human to human, information handling from machine to machine, searching and selecting information and data exchange amongst human and machine. It was Internet technology, that set in motion the remarkable change in the primary and supporting processes used in today's companies. These companies have transformed into customer open ends, where the company's innovation is shared with customers (Hippel, 2005; Ridder, 2006). In education changes have also come through based on information technology: educational practices have evolved from 'computer based training' to 'online learning' and a successive 'learning on demand' practice is emerging. These practices are built on successive technologies and prepare the way for new educational practices with changing competencies from fact-knowing to fact-sharing. In other words, where internal memory is freely available, one can use facts and figures obtained from external memories, such as knowledge bases, wikis and repositories. Internalisation and externalisation of knowledge are both used.

If we consider the sections collected in this chapter we may conclude that human kind is constantly on the move to develop itself. There have been periods of continuing progress and there were periods of radical changes and switches. This counts for society, technology, for universities, education and research. The collected information in this literature chapter gave the author stimulus to reflect on the movements of human kind, written down in Appendix A called 'Reflection'.
If we consider all movements taking place since about the 1960s, we can see that we are moving towards a swivel point on our way to the next change in history facilitated by Internet technology. Higher education will not escape this historical change and it is under pressure indeed.

3.8.1 Money Matters

Today, the financial situation of a university is important, it matters significantly whether the financial books show positive results or negative ones. In the early days of the university students collected money to reward teachers for their inspiring lectures. Such payments grew into salaries. Nowadays, commonly governments take care of primary financial flows for universities. Although universities maintain their scientific independence the government directly influences the university's research agenda by pushing organisational procedures for cooperation between institutions and by providing funding for certain research areas only (Plasterk, 2007). Moreover, government's attitudes are changing to a view where universities are seen as knowledge incubators with economic potential (Wissema, 2005).

The means and goods of our modern western society are increasingly expressed in money or economic derivatives, stock values, shares and alike. Such an economics driven system is called 'monetarism', of which Karl Marx apparently had a clear foresight considering his 'Das Kapital; Kritik der politischen Oekonomie' (Lipschits, 1984; Marx, 1890). Most of the steering in our money-society of businesses, corporations, and even in non-profit institutes, is done by financial management respectively financial managers. Money is the one intangible that can immediately be transferred into hard currency, it is countable and needs no explanation. Profit is good and loss is dramatic, even equality counts as decline today, if one may believe the daily messages from the stock markets.

Steering mechanisms within higher education started by following financial management as practiced in businesses in our economic driven society. We must be aware not to mistreat a student as an output product or plain money. Such mistreatment may come about due to diminishing subsidies that push universities to collect money from other sources. However, the main resource remains the students' fees and these are certainly easy to calculate (Plasterk, 2007). For instance increase the number of registered students and more money will flow into the university's purse. A second objective is to take care that students finish their study according to the nominal term of their study, because delayed students hold places and do not bring in money.
With the economic driven society in mind, but argued from another paradigm, it might be important to have strong bonds between alumni and their alma mater because valorisation of knowledge is becoming a main topic for universities. With the future in mind universities must invest in its output to see students not only as graduates but also as potential alumnus, or as university extension, or as agent, who submits authentic projects that bring in additional funds. These authentic projects may count as alternative finances for the university and as authentic learning trajectories for graduates. The counter achievement of universities is to solve such submitted projects professionally. As a consequence the student should be considered as human capital, as knowledge value, as a capital asset (Coleman, 1988). Even stronger put; the student is university's capital.

Financial money matters were described to urge universities to approach their financial situation from another economic and marketing perspective, or paradigm. The current one is based on mass-production or profit-per-unit where the student is the counting unit. The proposed financial paradigm is worked out in Chapter 8 where additional funding comes from educational projects producing knowledge products and knowledge services, hence, universities must expand their financial systems where *money matters*.

3.8.2 Society Rules

Society is a complex self-organising system. It shapes its own situation out of multiple cultural, technical and civil regulations. It is not the rulers or dictators that shape society, people act with or against the counting rules, and the ruled organisations are present in a certain time frame. Society shapes or reshapes itself over time. The duration of such shapes is hard to predict, but if we are willing to follow the Kondratieff cycles then the innovation and spreading of the fifth Kondratieff cycle will continue to rise for about another 10 years, it will take another 20 years before a next wave comes into sight, see Figure 8. This coincides with the century waves of the American Office of Technology Assessment concerning the workforce changing from agrarian to industrial to informational by the year 2045, as was discussed in Section 3.2.4.

The university timeline, depicted in Figure 7, shows that we are on our way to a next generation university with a focus on valorisation and the market as ruler for social sound projects and products. Dominance is given to valorisation of knowledge as the way to transpose scientific knowledge into usable products and into money. Engineering universities especially may profit from valorisation because of their creating attitude and ground principles. This process is already emerging if we consider the increase in science parks around university campuses.
On the historical timeline the transition period from the first to the second generation university can be related to the French Revolution and contemporary revolutionary wars. The transition from the second to third generation university will be facilitated by the Internet revolution. The Internet provides corporations with completely changed business processes, flexible and volatile (Friedman, 2007). The Internet has given rise to online networks with informational and communicational possibilities for society in general, to shared data sources and distributed computer functionalities, to harvesting repositories and grid computing, and it will evolve into intelligent (automated) information exchanges between human and machine, machine and machine and human and human facilitated by technology.

A shaping society was sketched where valorisation will become dominant. The shaping of this society comes from all sorts of influences. The university is urged to focus on creation and application of knowledge products and knowledge services. Such valorisation brings with it a serious need to consider ethics, aesthetics, sustainability, environmental issues and life-long-learning. Society will put assignments to universities to focus on sustainable projects, hence, education must expand with issues where *society rules*.

3.8.3 Technologies Support

The Internet revolution can be seen as a revolution of 'human with assisting machines' for a knowledge economy in the information age against an era of the 'machine assisting human' to produce gains as was typical in the industrial era. In the industrial era manufacturers dominated the economy, their machines brought prosperity to the manufacturers and to the upperclasses, but the life of the masses was worth nothing. As soon as one part of a labourer's craftsmanship was mechanised, the machine took over the guild and workers lost their 'labour value' to become an extension of the machine. Marx called these workers proletarian. Proletarians were seen and treated as extensions from the machineries without any rights to good work conditions (Marx, 1890). In the information age, however, we are growing into a society where almost anyone can read and write and be adequately housed with good living conditions. New sciences, such as leisure and tourism management, have come into being to investigate how humans use their free time and space (Poel, 2002). We are arriving in an époque where machines are extensions of us, for instance, machines have become increasingly smaller, are used daily i.e. mobiles, computers, kitchen tools, washing and dishing machines, calculators, drills, punching tools, et cetera. Other tools have been mechanised and transformed into powerful extensions for human use, such as cranes and excavators, which allow us to move heavier loads than human power ever could. The use of such tools as our extensions is so natural that people call such extensions their strong arms, their extended ears, their calculators, their extended fingers, their memories and their avatars, as though body and machine were one of a kind. In contrast there are machines which have grown tremendously, for instance, petrochemical plants and drilling rigs that still need human labour as the machines' extension. Trade unions have overcome the bad work conditions of the past and payment for work is now dependent on the skills required and demonstrated to do a specific job.

Extensions are developing into more than just extensions. As we become used to working with extensions as body parts we begin increasingly to treat the inanimate extension as an intelligent partner. We can take measuring instruments such as barometers, thermometers, voltmeters and gasmeters, as an example. In the early days we measured values while connecting an instrument and wrote down the needle's pointed value. When you walked away from the instrument it was hard to argue that the instrument was no longer measuring just because there was no operator (Bruijn, 2004), indeed when we connected a recording instrument we understood that it would continue to measure over time. Moreover, we could automate actions to measure values by connecting a computer or other electronic circuit. Such connected intelligent interfaces are increasingly able to operate on their own, take for instance the thermo regulator in our house, the injection engine in our car, safety alarms in bank buildings and the robotic tools found in industry.

If we consider emerging technologies, such as web services for communication between two or more inanimate data sources, harvesting repositories which collect tables of contents from external informational resources, online game worlds connecting multiple users into one interactive world and information sources moderated through hundreds of professionals, then we are growing into a society of humans and machines. We will be living in a hybrid world of social and inanimate reality.

A situation for technology was sketched where it grows from a tool used to support people into a tool used as a personal extention. Hence, the university is urged to use supporting technologies to the fullest to educate their students in how to deal with a hybrid world of humans and machines, to implement educational practices that fit the life-long-learning and that honours the innate ICT skills of digital natives as they learn and work in environments where *technologies support*.

3.8.4 Education Demands

Computers and network introduced new ways of multimedial communication and collaboration. Information technologies increased the number of intangible products such as software applications for office and instruction, and other virtual products such as images, music, videos, models, simulations and games. Intangibles for teaching and learning can be valorised. However, today's university is not selling its intangible learning materials directly. Instead a trend is rising to make learning materials accessible to the public for free, called Open Education Resources (OER) or open courseware. Open courseware are learning materials that are freely available to attract students to join the providing universities. When a student becomes a member of their university's intellectual collective networks they are immersed in the university's pedagogies, they are set to work in authentic projects that count, they are instructed by the university's top researchers, they are permitted to use the university's top facilities and they are vital for the prestigious institute. These are the issues to win the students' submission and subsequently their fees as a money asset. Should the teacher not be given incentives to output his education resources to keep the OER moving? Why should such educational output not be valued with credits to earn money for the department?

A university must explore educational ways with its technological systems to assist students with different sorts of knowledge through multiple instruction and learning strategies. The current instruction factory with teachers, aims at internalising knowledge such as know-that, know-how and know-why. However, to complete the knowledge packages the university must introduce educational processes for externalisation, know-where, and for mastering multi-disciplinary communication with know-between and know-across instruction and practicals. Know-between, know-across and know-where are taught by another type of lecturers. Some examples are presented hereunder, practices may already be operational, however, not institutionalised:

- Episteme as know-that for facts, figures and formulas, needed for projects may be stored in online knowledge bases or rather repositories with additional social software portals as mentioned in Section 3.4.4. The university-hosted repositories operate as virtual knowledge centres where learning objects are stored and managed, where appropriate software applications can be obtained including their support. The associated portals support dedicated communities as owners of content with communication, sharing and object management features. Dedicated communities and virtual knowledge centres may be created in such way for every mono-disciplinary and multi-disciplinary projects. Repositories are independent of the university's hierarchy and may stretch the universities borders to span a global network of peers. The first examples of such systems are already here, for instance mathematical learning objects for first-year student with mathematical deficiencies (Gastel et al., 2007; Zanden & Cuypers, 2007).
- Techne as 'know-how' or white-box thinking may be supported with modeling and simulation technologies. More game like applications, or essential parts of it, have come on the market or become available through open source. Such electronical modelling assists in creating academic apparatuses and programs, such as serious games (Egenfeldt-Nielsen, 2005, 2006; Kebritchi & Hirume, 2008).
- Phronesis as 'know-why' is learned in practicals, workshops, hands-ons, and studios. Most universities already have well equipped environments and laboratories but often lack authentic valorisation projects where ethics really counts.
- Nous as 'know-between' as reasoning and logical deduction may be supported with debating arenas, both large and small, with peer opponents or even contests with strong opponents, or possibly even in inter-university arenas. Authentic projects with their intrinsic multi-disciplinary exchange of design models and methods are the perfect arena for matching and discussing the methods and techniques of several domains.
- Sophia as 'know-across', stands for overall wisdom and leadership, is for managing multi-disciplinary educational tracks and may be applied by professional coaches, alumni, even sometimes master student and PhD students.
- Once online knowledge bases are readily available then the 'know-where' produced by Connectivism will become more important. Libraries are already teaching courses to train students in how to find validated information.

The OER movement urges universities to work out new metrics to value their educational output. The university is urged also to develop ways of educational practices that meet characteristics of the new educational paradigm shown in Table 3, with characteristics such as 'full immersion', 'passion', 'all year long', 'multi-disciplinary', and 'coaching'. Such learning practices meet depth with several levels of difficulty, scholar, bachelor, master and PhD, and breadth with several types of knowledge, know-that, know-how, know-why, know-between, know-across and know-where. These should be the practices that *education demands*.

3.8.5 Answering Research Sub Question A

Many developments were collected, in our explorative literature search, that play their part in the shaping of today's university. Typical characteristics of the currently shaping third generation university require students, staff and the institute to adapt, to adopt a new input-financial model, new educational practices and their technologies, to produce new bonding programs for students and alumni, to create flexible study programs, and to become accountable for valorisation using corresponding metrics.

In answering the research sub question *"What developments have had or have an influence on higher education?"* this concluding section contains a list of main influences and their consequences presented in Table 8.

Table 8: Higher Education Influences and Counter Measurements as collected by A.H.W. van der Zanden

Influence	*Counter Measurement*
Diminishing subsidies	*Valorisation of education and research becomes more important, it will evolve into its own third primary process. Education and research have to earn money by creating alternative incomes. Accordingly, new metrics need to be set up for education and research outputs.*
Consumer's world	*Students must be equipped with sense and responce strategies to operate in a multi-disciplinary world, one which they will face when they start work. The university must focus on creation and operationalisation of knowledge products and services. Entrepreneurship must be institutionalised to valorise these knowledge products and services. The mono-disciplines have to match each others' approaches, methods and techniques with multi-disciplinary instruction and practice.*
Complex multi-faceted projects	*The education process will differentiate into teaching mono-disciplinary educational tracks and coaching multi-disciplinary projects, which will be authentic ill-structured projects from paying customers. Teachers must prepare to deal with such developments.*
Mass education and higher student mobility	*The higher income for universities due to increasing student numbers is welcome but the alma mater umbilical bond between student and university weakens, hence the university can emphasise its uniqueness of education by institutionalising multi-disciplinary education tracks. The university can strengthen the alma mater feeling also with social programmes and interacting human networks.*
Today's student is tomorrow's alumnus and customer.	*Customers will contribute with authentic project assignments for multi-disciplinary education tracks when the alma mater feeling remains strong, hence, universities should nourish students instead of the efficiency; love the person and not the process. Emphasise on motivation of the student and it will pay back tomorrow. It looks like a trend is setting for the funding of professoral chairs by corporations and entrepreneurs, but students must be considered the university's capital.*
Shorter knowledge life cycles and shorter product to market cycles	*A life-long-learning attitude for the student and alumnus should be supported by taking care of online and validated information centres or knowledge centres built on repository architectures with additional social software portals. Educational achievements explained in graduating figures should be extended with portfolios and degree supplements to indicate obtained levels of knowledge, skills and competences, but also for communicative, informational and managerial skills.*
Open Education Resource movement	*The OER movement is organising in world wide structures. The trend to open knowledge for free seems a non-stoppable one, hence, an incentive system is needed for education to contribute to the movement. New metrics are necessary to value educational output and motivate the teaching force to collaborate.*

Considering all the mentioned parts and arguments in this chapter we want to pose that Internet technology brought a comprehensive revolution; a revolution in society, in university, in business, in technology and also in education. Education must respond to the developments presented in this chapter because education is a sense of its surrounding culture and society. The ultimate educational changes to strive for can be considered 'a cry for freedom' to break out of the chains of the industrial era; break from the normalised lecture hours, of the control system, the long holidays, the talking head instruction and of the faculty boundaries with mono-disciplines as isolated educational tracks of the past. The instruction factory is not to be banned, it will retain its value as a means to teach mono-disciplines. Valorisation is becoming the third primary process as it gains its position for shaping the next generation university.

It was the French Revolution that brought enormous changes within the Western world, today the globalisation of economics, of markets, of products, with English as language of communication, supported and driven by Internet technologies, is causing enormous changes on a global scale. The French Revolution came at a time of transition from the first to the second generation university, now the Internet revolution comes at the transition from the second to the third generation university. We will not see this transition in such radical light, as we are part of it, and it is hard to predict from inside-out what exactly is happening. In time we will be able to look back and put the changes in perspective. For now we will collect the little questions that we have been posing ourselves in the Chapters 2 and 3.

a. *We wondered if educational technology, as instigator instead of only being considered as a catalyst, can lead us to future educational practices (Section 2.1).*
b. *We wondered if the S-shaped curve, as product forecasting approach, can be used to catch the growth of educational technology in operation (Section 2.2).*
c. *We wondered if educational technology in operation can show us appropriation and structuration processes (Section 2.3).*
d. *We wondered if the critical mass can be caught for the implementation of VLEs (Section 2.4.1).*
e. *We wondered if the VLE's diffusion can be caught in Rogers's adopter categories (Section 2.4.1).*
f. *We wondered if the VLE's growth can be caught in rate-of-change and lifespan parameters (Section 2.4.2).*
g. *We wondered how the CIM model can be applied within higher education to prosper an entrepreneurial state of mind (Section 2.4.3).*
h. *We wondered how higher education can take advantage of instant information access within the learning and working environment (Section 3.1.4).*
i. *We wondered how valorisation as third primary process can be embraced and implemented within higher education (Section 3.1.4).*
j. *We wondered how a metric system can be fit within higher education for both education and research output (Section 3.2.2).*
k. *We wondered how successive technological innovations, presupposed that a next Kondratieff wave is to emerge around the 2040s, coincide with an educational technology forecast (Section 3.2.3).*
l. *We wondered if the students and instructors of today's educational technology show signs of uses that typically belong to such technologies (Section 3.2.4).*
m. *We wondered how higher education can unleash itself from the industrial chains as listed in Table 3 (Section 3.2.5).*
n. *We wondered how the teacher's job can be reshaped to face the many microtrends (Section 3.2.7).*
o. *We wondered if the VLE as modern technology has led to new pedagogies within higher education (Section 3.2.7).*
p. *We wondered how information technology eras are related with educational technologies (Section 3.3.6).*
q. *We wondered how open access artefacts, as free learning materials for everybody, will influence the university's position (Section 3.4.6).*
r. *We wondered if Internet literacies, supposed to be related to online learning, can be recognised in the VLE uses (Section 3.5.4).*
s. *We wondered which educational practice can facilitate formal and informal learning situations maximally enhanced with ICT technologies (Section 3.6.7).*
t. *We wondered which university setting can address the discerned types of knowledge within the education practice (Section 3.7.10).*

Notwithstanding, the many developments described in this chapter indicate that the changes towards the transition from a second to third generation university began in the 1960s and continue to accelerate. Considering the Sorites paradox we cannot know exactly where we are within the change process, but the many developments give us an indication of which direction we are heading. We just have to focus to get a grip on the voyage we are undertaking. Such a focus is worked out in Chapter 8 to collect a set of key principles for educational management in order to shape the next generation higher education.

4 INDICATORS FOR VLE USES AND DATA COLLECTION

Utterly agape, Professor Langdon read the four lines again,
clockwise in sequence: top, right, bottom, left.
When he was done, he exhaled.
There was no doubt in his mind.
"You found it, Ms. Vetra."

From Angels & Demons
by Dan Brown (Brown, 2005)

4.1 INTRODUCTION

We will now explore current technology as applied within today's educational practice. According to our literature search, educational technology has played an important role since the 1960s. In the last decade, the virtual learning environment (VLE) has taken a firm place within higher education institutes. A recent exploration has shown that the Blackboard VLE has the largest market share in the United States and Western Europe (Bradford et al., 2007; Falvo & Johnson, 2007), thus because Blackboard has become so dominant, we chose to use this VLE as our unit of analysis.

VLE's began to be used within the educational practice by the end of the 1990s. Many institutions have evaluated the educational uses of these learning environments. In the Netherlands, however, the educational evaluation research thus far has been mainly of a qualitative nature and often the results are not published; at least this is what we found out by contacting colleagues in the field and at conferences. Qualitative studies that have been published showed indications on the uses of VLE such as '... the VLE is used extensively ...' and '... students complain when the VLE is not available ...' to indicate the importance of the VLE. Although such answers are informative, they remain indicative and do not provide insight into the numbers and development of the various uses of a VLE and its merits for teaching and learning. We believe that quantitative data would give distinct added-value for answering questions on issues such as the merits and the drawbacks of practicing with a VLE. Therefore, we used qualitative and quantitative approaches for our explorative case study. We chose to collect empirical data on the Blackboard VLE, in use since 1999 at Delft University of Technology (DUT).

To obtain the qualitative data we conducted an online survey to collect teachers' views and opinions about their practices with the VLE. To obtain the quantitative data we explored DUT Blackboard VLE to determine which of its logging data would be relevant for answering research sub question B, which is *"How is the Blackboard VLE used within higher education?"*. The qualitative and quantitative approaches together provided us with a more comprehensive picture of the uses of the VLE, thus it helped us to gain an overview of the merits and drawbacks of using the Blackboard VLE for education in general.

Table 9: Questions and corresponding Indicators concerning the Blackboard VLE Uses

Initial Questions	**Indicators**
b – catch the VLE's growth	*b1 - number of initiated communities* *b2 - number of initiated courses* *b3 - number of active communities* *b4 - number of active courses* *b5 - ratio of initiated versus active communities* *b6 - ratio of initiated versus active courses* *b7 - lifespan period of communities* *b8 - lifespan period of courses*
c – catch appropriation and structuration	*c1 - number of active community users* *c2 - number of active course users* *c3 - types of community user (student, faculty, staff, other)* *c4 - types of course user (student, faculty, staff, other)* *c5 - seat time duration for communities* *c6 - seat time duration for courses* *c7 - seat time moment for communities* *c8 - seat time moment for courses* *c9 - seat time activities for communities* *c10 - seat time activities for courses* *c11 - one-way communication activities (messages)* *c12 - two-way communication activities (discussion board)*
d – catch the critical mass of the VLE	*to be derived from the figures of initial question b – catch the VLE's growth*
e – catch the VLE's diffusion pattern	*d1 - number of institutions (country, city)* *d2 - types of institution (higher education, others)* *d3 - types of profession (Blackboard's classification)* *d4 - install date* *d5 - release version*
f – catch VLE's rate-of-change and lifespan	*to be derived from the figures of initial question b – catch the VLE's growth*

We focused on collecting the data needed to test hypotheses 1: *"Implementation of VLE educational technology will grow along an S-shaped curve in time"*, and hypotheses 2: *"The uses of the VLE functionalities will follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve"*. Yin (2002) argues that it is common practice for case study research that a first explorative case is scrutinised to explore the span of possibilities within a larger case (Yin, 2002). In this chapter, we describe our explorative case study to show how we found the relevant empirical data for the system's uses and the

users' uses of the VLE. The little questions b, c, d, and e of Section 3.8.5 helped us to choose the empirical data needed to be retrieved from the VLE logs. We have converted these little questions into operational indicators, as are presented in Table 9, that could be retrieved from the logged items.
Given that the total amount of logging data in the DUT case already exceeded more than half a Terabyte (> 500 Gigabyte) it was necessary to reduce the amount of data. Moreover, when reducing raw data we had to focus sharply on the relevance of the data. We did not want to throw away interesting data, yet we needed to reduce the data as much as possible because, for a reliable quantitative research sample, many other institute datasets needed to be collected and analysed.

The approaches used in the DUT case study and the results for its qualitative and quantitative investigations are presented in this chapter. As far as the other cases are concerned, we have focussed on quantitative analysis only. Our multi-case investigation was aimed at equivalent and independent datasets. Consequently, we have set up collection queries for easy and anonymous accumulation of appropriate logging data from many other institutions. After the data collection phase, cleansing and classification of the data was done before storing the appropriate data in our research database.

4.2 Online Survey as Qualitative Part of DUT Case Study

We questioned teachers of the Delft University of Technology (DUT) for their views about the uses of ICT in general and the Blackboard VLE in particular for the qualitative part of our explorative case study (Zanden, 2008). The survey was done using the NetQ tool from Netquestionnares Beheer BV. The questionnaire held 32 questions in four main categories, which were general questions about the respondents and their 'educational practice', about 'ICT in education', about users' uses of the Blackboard VLE', and about 'the Blackboard support service' from our own university. The Delft University of Technology has eight faculties, represented in the questionnaire by 135 respondents. In Table 10 the goodness-of-fit is presented for the distribution of the teachers over the faculties, six out of eigth faculties scored as expected. About a third of the responding instructors teach at more than one faculty, hence the number of 179 instead of 135. A complete overview of the questionnaire is presented in Appendix B. Only the relevant questions and the results are presented here.

Table 10: Overview and Goodness-of-fit of Respondents

Faculties of Delft University of Technology	*Total number of Faculty & Staff*	*Ratio*	*Expected frequency*	*Obtained frequency*
Architecture (A)	*375*	*0.12*	*21*	*22*
Civil Engineering and Geosciences (CEG)	*414*	*0.13*	*23*	*21*
Electrical Engineering, Mathematics and Computer Sciences (EEMCS)	*593*	*0.18*	*33*	*28*
Industrial Design Engineering (IDE)	*201*	*0.06*	*11*	*14*
Aerospace Engineering (AE)	*332*	*0.10*	*18*	*20*
Technology, Policy and Management (TPM)	*257*	*0.08*	*14*	*37*
Applied Sciences (AS)	*656*	*0.20*	*36*	*16*
Mechanical, Maritime and Materials Engineering (3mE)	*412*	*0.13*	*23*	*21*
Totals	*3240*	*1.00*	*179*	*179*

The teachers were asked which learning strategies or pedagogical approaches they applied within their daily practices. They could choose for 'project-based learning', uses of techniques and methods on subject matter; 'productive learning', design activities for authentic situations; 'active learning', behaviourally and cognitively active when learning by doing; 'collaborative learning', joint intellectual efforts in groups; and 'coached self-study', individual assignments with personal coaching. An overview of their responses is presented in the composed graphs of Figure 19.

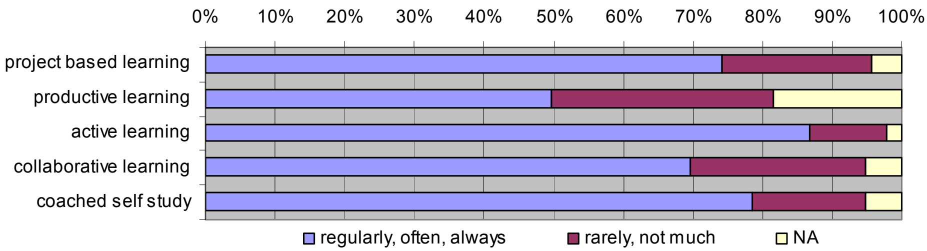


Figure 19: Composed Overview of Applied Learning Strategies (Pedagogical Approaches)(N=135)

As the figure shows, about three quarters of the respondents used project based learning within the Delft University of Technology. About twenty percent used it rarely to not much, and just less than five percent did not think that project based learning was an appropriate learning method. Collaborative learning and self-study had about a same coverage. However, only fifty percent of the respondents applied productive learning. In contrast, active learning was considered to be a fully applied and implemented learning strategy.

The figures indicate varied use of different pedagogical approaches, where active learning seems to be the leading learning strategy for DUT teachers. We could conclude that productive learning was still lagged a bit behind while we would expect that the construction faculties, 3 out of 8, would score higher on such productive learning methods. Next to the learning strategies, it was interesting to see what teaching activities the faculties applied within their daily educational practices. The results with respect to the application of teaching activities are presented in Figure 20.

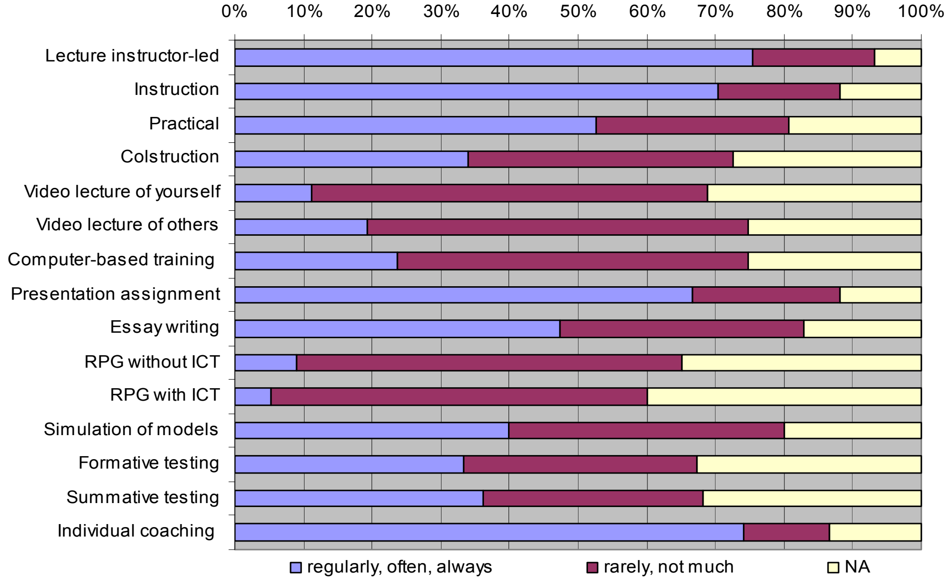


Figure 20: Composed Overview of Applied Teaching Activities (N=135)

It becomes clear that the instructor-led lecture, instruction, presentation of assignments and individual coaching are common practice. However, such results can contradict with the results for the pedagogical approaches because the chosen pedagogies imply an active and more self-motivating attitude on behalf of the students. The practicals were used for about fifty percent and essay writing was a common practice. Formative and summative testing based on ICT technologies was used within the daily practice. Computer based training, which was very popular in the 1980s and 1990s, is still present. In contrast, we did not find much use of role-playing games (RPG), use of which remains rare within the DUT educational practice. We may conclude that technology enhanced teaching activities, such as video materials and training applications, are used in a modest way.

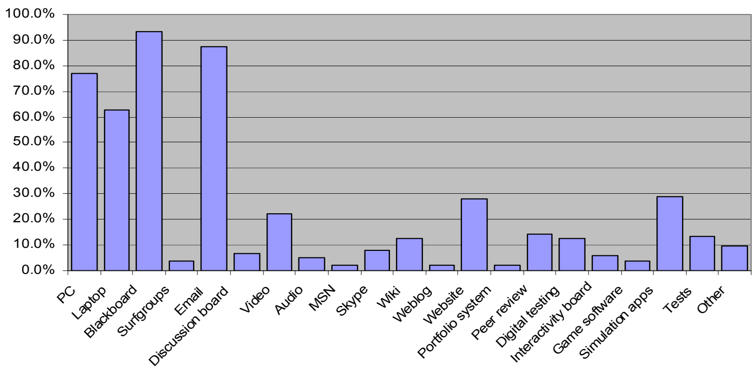


Figure 21: Overview of ICT Tools within Daily Educational Practices (N=135)

The next question focused on the application of ICT tools by the teachers. An overview of the responses to which ICT tools were being used on a daily basis is given in Figure 21.

Considering the graph, it seems valid to say that the Blackboard VLE has been almost completely implemented. About three-quarters of the teachers use both PCs and laptops, while email is a very popular medium. Other online communication modes are clearly less popular, such as the discussion board, MSN, weblog and Skype. Online collaboration was only set to work in some situations, and it became clear that the traditional lecture still has a strong position in education.Websites were widely used as are simulation applications. The teachers were asked which other ICT tools they used in their daily educational practice. The 'other' category holds ICT equipment such as webcams, mobile phones, repositories, web applications and dedicated software. Considering the high level of application of ICT tools one may conclude that the office automation environment was more than adequate at DUT.

We asked the teachers to give their opinions on the added value of the Blackboard VLE for their daily educational practice, the results are presented in the composed graphs of Figure 22. The four top items were teacher-led issues, more related to subject matter and its handling, the bottom three items were more student-oriented activities aimed at their possible collaboration and cooperation. The teachers responded that managing learning materials and other subject matter had very much improved now that they could handle it at just one place in the Blackboard VLE.
The distribution of subject matter was made very easy, as was making the announcements. Only one place was required to send an announcement with the certainty that every enrolled student would get the message as long as they logged in, was very convenient. The teachers thought that these things made their lives easier and more efficient.

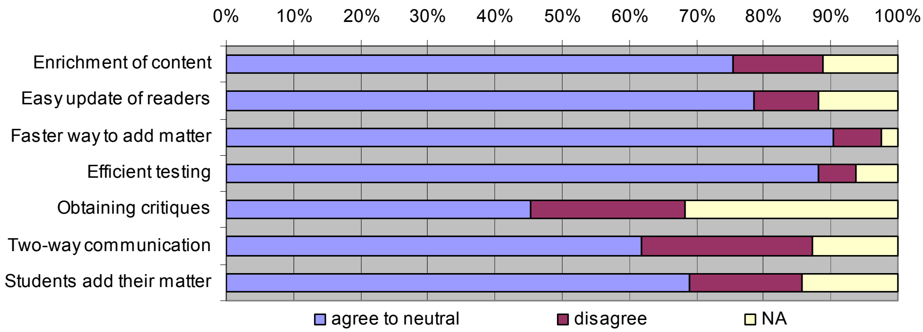


Figure 22: Composed Overview of the Extent of Quality of Applied Educational Practices (N=135)

Teachers found responding to students' questions outside normal teaching hours time consuming. The teachers had been trying to avoid such activities. They did like to receive online critiques about subject matter and other relevant items, but they did not want to give answers in online conversations or for non-related questions. This generated too much unstructured work in addition to their teaching function. Finally, the teachers felt uncomfortable about letting students add subject matter to their carefully composed knowledge base. They argued it is their responsibility and role to control the quality of resources made available for learning.

Concluding we can say that ease of use and efficiency are the words that are important for teachers when using ICT tools. They see ICT as a quantitative add-on for education. In their view ICT is a support tool for their existing educational practice rather than an engine for change. Experimenting with new teaching strategies is only of interest when it saves time or work.

The following part of the questionnaire was aimed at the Blackboard VLE. Open questions started the section. Blackboard was introduced at DUT in 1999. The number of respondents to this part on the Blackboard VLE questions was 120. We asked them what they thought of the functionalities of the VLE and its user-friendliness: *"What are the three most convenient functionalities and what are the three most detested ones?"* The results according to their order of submission are shown in Table 11.

Table 11: Convenient Functionalities and Inconvenient Functionalities (N=120)

Convenient Functionalities			Inconvenient Functionalities	
1st place	2nd place	3rd place	1st place	2nd place
Announcements (27%) Course Docs (15%) Email (13%) File Exchange (9%) Publicing (7%) Other (< 5%)	Course Docs (22%) Email (18%) Announce's (14%) Publicing (7%) Other (< 5%)	Email (17%) Announce's (12%) Grades (11%) Publicing (7%) Other (< 5%)	Clumsy (20 %) Many clicks (19%) Grades (8%) Other (< 5%)	Many clicks (14%) Clumsy (14%) Other (< 5%)

Announcements appeared to be a popular functionality with its share of 27 percent. Course Docs was a very good second functionality, directly followed by Email as the third. File exchange and Publishing were also relatively frequently used features. All the other functionalities had a share below 5 percent. What the teachers did mention as user-unfriendly features were the many clicks required to do tasks and the sometimes 'illogical' placing of the functionalities, which was summarised as clumsy. Only Grades had a share of more than 5 percent as an inconvenient functionality.

In their main answers on the next question "*For what educational purposes do you set the Blackboard VLE to work?*" the teachers mentioned that announcements as one-way communication helped them a lot to inform students instantly about subject matter, events, figures, planning and assignments. The teachers were also very satisfied with the VLE's logic distribution feature, designed to put online learning materials, references to readers, old exams, PowerPoint lectures, files for software applications, testing materials and literature online. These answers are consistent with the answers given on the former question presented in Table 11.

After the open questions we wanted to know the teachers' views on the extent of use of Blackboard: "*To what extent do you apply Blackboard in your educational practice*" on a 5-point Likert scale. The functions, distribution of learning materials and announcements were fully applied. Online collaboration and the use of videos for instruction were poorly used functionalities. Here we need to mention that a new policy has been launched at the DUT to make a new service for students called *"missed lecture"*. This service is aimed at recording lectures and making them available online within a few days, in both streaming and downloadable formats. The results are listed in Figure 23.

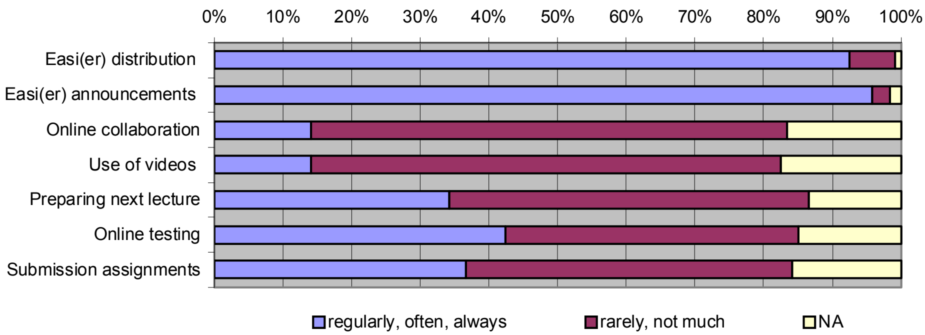


Figure 23: The Extent of Application of DUT Blackboard VLE in the Educational Practice (=120)

The Blackboard VLE is mainly used to work and to improve the quality of lectures. Preparation of materials and instructions for the next lecture are put online so that the students can prepare themselves with prior, necessary knowledge taken from readers or assignments. Sometimes quizzes or tests are put online for the same reason or to provide training programs for upcoming examinations. Finally, the VLE is sometimes used as logistic collector for assignments. The students are expected to conduct their work before a submission deadline.

4.2.1 Conclusion Online Survey for DUT Case Study

We asked the teachers their opinions on the merits and drawbacks of the Blackboard VLE for their educational practice, and their responses were surprisingly positive. According to the teachers, the VLE has led to a quantitative impulse forward, driven by its efficient functionalities, for the distribution of learning materials and announcements. The disadvantage of too many mouse clicks per function and the, sometimes 'illogical' place of, buttons were easily outweighed by such efficiency benefits. Still the teachers argued that education has not changed. They can still practice using the same lectures without the Blackboard VLE, however, the teachers do not want to give up online management of their learning materials. Nor did they want to give up the easy distribution and easy messaging tools. According to the teachers, efficiency and ease of use are important issues when ICT is implemented within education.

> *Teachers welcomed the Blackboard VLE to speed up educational processes, such as messaging and distribution of learning materials, and its ease of use.*

The outcomes of the online survey taught us that the DUT teachers considered the Blackboard VLE to be a welcome tool within their daily practice. When we collected empirical data from the logs of the Blackboard VLE we have kept these teacher's opinions in mind to fit the qualitative with the quantitative approaches.

> *The Blackboard VLE has not yet led to innovative pedagogies.*

We may conclude that usage of the Blackboard VLE has taken its place in the daily educational practice of DUT. In our case its use has not yet led to innovative pedagogies, however, the VLE has sped up several processes and made them easier to handle, especially when we consider distribution of learning materials and messaging.

4.3 BLACKBOARD VLE EXPLORATION AS QUANTITATIVE PART OF DUT CASE STUDY

We used a case study approach in order to get an in-depth insight in the Blackboard VLE uses and to help us to find the variables and factors relevant for our data collection activities (Galliers, 1992; Yin, 1994). We explored what sort of logging data were available and retrievable, what parts were appropriate for our investigation, and how such data could be collected. As an important part of the strategy, the pilot explorative case study analysis was designed to help us reduce and structure the data collection process used to acquire cases from other institutions. We refined our data collection plan for acquiring these datasets both in content and procedure, and the pilot case provided considerable insight into the issues studied.

4.3.1 VLE Connection for Data Retrieval

Our aim for the quantitative part of the DUT case was to reveal structural patterns and dependencies in the Blackboard VLE logging data with respect to the uses of teachers and students, and with respect to the growth and diffusion of the VLE system, see Table 9.
We explored what logging data were available, how the logging was done, and how the data could be revealed. Most important of all was to find the logging data, which held the information needed to answer the research sub question B. Logging data can give us information on factual actions, when for instance, one of the VLE's applications was used, by whom, how often, and how long, however, they do not tell us how that particular application was used within whatever educational practice. Thus, we knew that a function was used but not what it was used for.

We aimed to explore regularities of use. This data could then be used to test our two hypotheses. As a consequence, we had to map the structure of the VLE database to examine and analyse the log files. It became clear that during the study period several releases of the Blackboard VLE were operational and a huge change in the underlying database structure occurred with the upgrade from version 5.x to version 6.x took place. Considering the customer base of the Blackboard VLE at the time, when almost every client used version 6.0 and higher, the data selection and analyses were focused on the database structure of version 6.0 and higher. However, it became apparent that, due to the upgrade huge amounts of version 5.x data had become scattered in a less-structured way when that migration of Blackboard version 5.x to 6.x took place. We had to find a way of work round this problem to reveal the ill-structured data for our purposes. Where in the earlier Blackboard versions a main table for approximately 150 different tracking areas (e.g. 'announcements', 'check_grade', 'send_email', 'cp_send_email') was available (Buelens et al., 2002), in versions 6.x plus of Blackboard some new main categories in separate databases were introduced. From these databases only the *BB_BB60* and *BB_BB60_STATS* contained data related to the educational uses of the VLE. *BB_BB60* contained data similar to the main tracking table as from earlier versions and the *BB_BB60_STATS* held tables with abstracted and accumulated data from that *BB_BB60* table. Therefore it seemed obvious to analyse the *BB_BB60* because it contained the original and complete data.
We then found that the data in *BB_BB60* were volatile (non-permanent) since the amounts of data grew too rapidly and sometimes exceeded one gigabyte per day. To handle such a tremendous growth of data a sweep function was built into Blackboard from version 6.x onward to reduce the amount of stored data regularly. Every institute was expected to decide on and adjust the period of clean-up of the *BB_BB60* data for appropriate budget reasons to meet its needs, because storage costs would rise too fast. With the sweep function in mind especially the Blackboard company developed its advance system reporting (ASR) database, which was the *BB_BB60_STATS* taken from the database server.

An extract of accumulated and associated data of the *BB_BB60* data remains permanently available in the ASR. A huge advantage of the ASR is the automatic accessibility provided for the system administrator who does no longer needs database access when generating management reports for the VLE. This allowed us to circumvent problems with access due to reasons of privacy. The system administrator's username was used to access the ASR is *BB_BB60_STATS*, indicated by the dotted line in Figure 24 in which a simplified picture of the architecture of the Blackboard VLE is depicted. The system administrator of the VLE is responsible for the application while the database administrator is responsible for the obtained data.

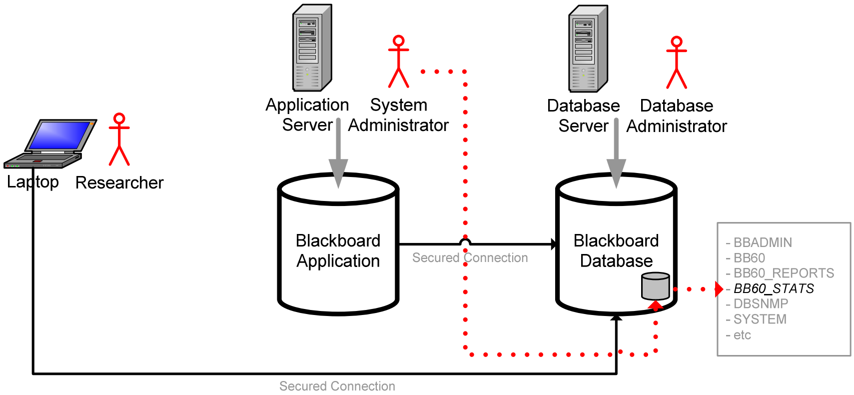


Figure 24: Simplified Architecture Overview of the Blackboard Virtual Learning Environment

Using the application Toolkit for Oracle (TOra) we were able to connect to the Blackboard database, which at the Delft University of Technology are Oracle databases. The Oracle 9i client application was installed in parellel to TOra on the researcher's laptop to connect to the databases using a virtual private network (VPN) connection. Using this connection we could fire queries at the database to explore what information could be made available. We had to be aware that complex queries could place a severe load on the database servers which were operational at the time of querying in a live environment.

4.3.1.1 Advanced System Reporting Database as Data Sandbox

We used the ASR database for collecting data with respect to the hypotheses because of its permanent availability. Every Blackboard's VLE with version 6.0 and higher has an ASR, which gave us the opportunity to obtain comparable data from multiple VLE's.

Table 12: Specification of Advanced System Reporting Database Tables from BB_BB60_STATS.

BB_BB60_STATS Table Names	*Rows*	*Description*
ACTIVITY_ACCUMULATOR	*13*	*Blackboard logged actions related to session handles*
APPLICATION	*19*	*Tools and features that appear in Blackboard*
COURSE_MAIN	*41*	*Course labels and dates of creation and modification*
COURSE_ROLES	*6*	*Six different roles of Blackboard course users*
COURSE_USERS	*26*	*Users and enrollment dates*
DATA_SOURCE	*5*	*Source of system used for execution*
INSTITUTION_ROLES	*9*	*Twenty different roles for the institute*
NAVIGATION_ITEM	*18*	*Internal handles per application*
SYSTEM_ROLES	*4*	*Eight different roles for system maintenance*
SYSTEM_TRACKING	*51*	*Collection tables of Blackboard usage on daily basis*
USERS	*50*	*User information classified for privacy reasons*
USER_ROLES	*6*	*Not used, empty records*

The *BB_BB60_STATS*, which are the same as the ASR database, hold 12 tables as listed in Table 12.

Blackboard logs all the system handlings due to the system's actions and users' actions. Every action taken, e.g. reading an announcement, update course information, or sending an e-mail, from any user of the Blackboard VLE generates at least one new record in the *ACTIVITY_ ACCUMULATOR* table. This means that the *ACTIVITY_ACCUMULATOR* was our source of the logging data. Records stored in the *ACTIVITY_ACCUMULATOR* hold criteria such as timestamps, course identification numbers, user identification numbers, application references and sorts of activities. The other tables hold the declarations of the available Blackboard applications or functionalities, an overview of the initiated courses, the possible user roles, and the internal handles from the *NAVIGATION_ITEM* table. An internal handle is a system call

to execute a command or application. Such a handle is initiated by the user when for instance, an application is selected such as ‘viewing a grade’, and by the system when for instance, the grade page of the user is loaded to present the grade.
The *SYSTEM_TRACKING* table holds the accumulated data taken from the original *BB_BB60* database, however, these accumulated data are error laden. Such errors come from the automatic accumulation of figures, thus you get the total of courses including try-out courses or courses without any student activities. The table *USER_ROLES* of the ASR was not used. A description of the *BB_BB60_STATS* table is given in Table 12 with the number of rows within that table. The rows or variables are presented in Figure 25 where an overview diagram of the ASR database and its attributes are presented as published by the Blackboard company (2004).

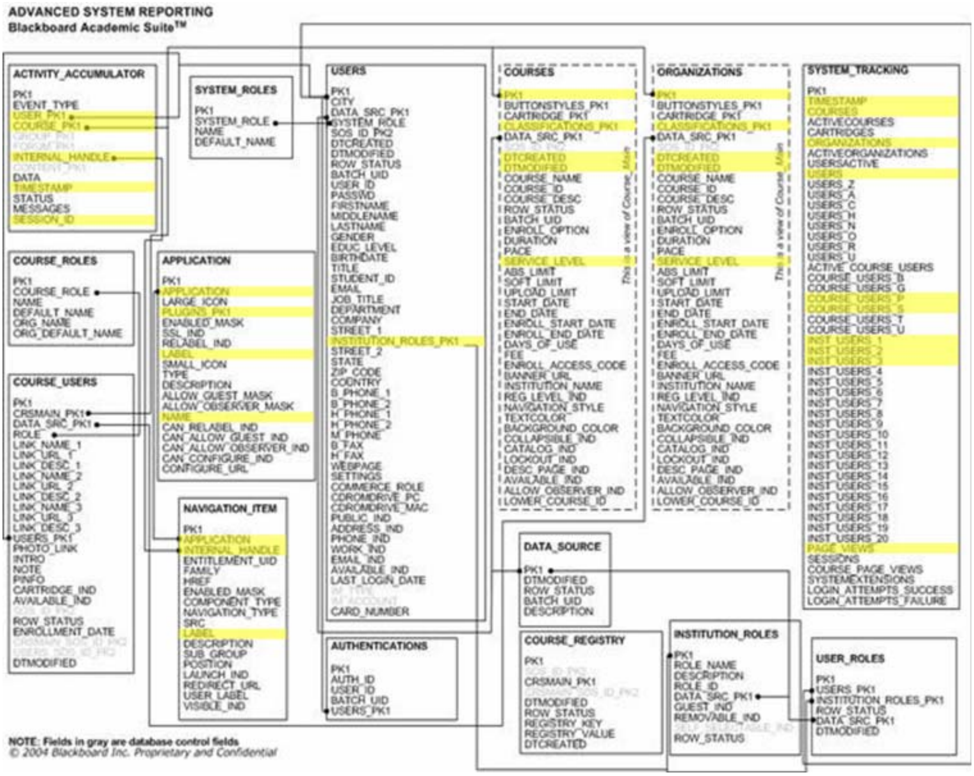


Figure 25: Advanced System Reporting Database from the Blackboard Virtual Learning Environment

We aimed our research at the *COURSE_MAIN, INSTITUTION_ROLES* and *SYSTEM_TRACKING* tables to obtain the empirical data for hypothesis 1 “Implementation of VLE educational technology will grow along an S-shaped curve”. The *COURSE_MAIN* holds the creation and last modification dates of all declared courses. The *INSTITUTION_ROLES* contains amongst other data the roles student, faculty and staff. The *SYSTEM_TRACKING* table holds consecutive records on a daily basis since the VLE came on line by storing snapshots of accumulated figures at 24:00 each 24 hour period. In other words, it contains growth figures for the VLE over time despite the knowledge that some data contain irregularities or flaws. Moreover, the *SYSTEM_TRACKING* table lists both ‘courses’ and ‘active courses’ as well as ‘organizations’ and ‘active organizations’. The adjective ‘active’ indicates that courses or organizations, which were applied as communities, had be used during the last 30 days, however, we wanted to indicate active courses as courses where students actively executed actions during the complete lifespan of the course.

We aimed to combine several tables from the ASR database to obtain the empirical data for Hypothesis 2 "The uses of the VLE functionalities will follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve". The relationship between the tables was taken to define the uses of the VLE. For instance, the *INTERNAL_HANDLE* can be used to link to the *ACTIVITY_ACCUMULATOR* table, the *NAVIGATION_ITEM* table and the *APPLICATION* table. Using this method we could construct what items and tools were accessed by users in a particular course. In the ASR diagram from Figure 25 the shared rows are detailed within the database. We have marked the variables that formed part of our data 'sandbox'. The data sandbox contained data, which was also collected from other institutions and used to conduct our study, and confront the two hypotheses. Extended and detailed descriptions of the *BB_BB60_STATS* columns and attributes are given in Appendix C.

Courses and organizations within the Blackboard VLE are very similar in functionalities with one exception, the flag '*service_level*' that indicates an 'F' for courses and a 'C' for organizations. Organizations are courses, which are put to work as communities. For our study we initially focused on the 'S' for 'student' or 'organisation member' and on the 'P' for 'instructor' or 'organisation leader' from the *COURSE_ROLES*, but it appeared that they were not always available, because of this we decided to aim at the roles '1' for 'student', '2' for 'faculty', and '3' for 'staff' taken from the *INSTITUTION_ROLES* when collecting logging data from other institutions.

4.3.1.2 Remarks for the Quantitative Study

A command function is available in the control panel of the Blackboard VLE for system administrators to use to generate standardised management reports. The *SYSTEM_TRACKING* table from the ASR database is the current table from which such management reports are generated. The Blackboard's system administrator is presented with the statistical figures in an 'overall summary of usage' functionality taken from the statistics page, which is accessible through the system administrator's control panel. Such management reports contain mixed figures, because every declared course in the database is considered and counted, including courses such as first attempts of teachers, try-out courses and show cases. Still, the ASR database can be used for collecting data, data that we needed for our study, and to confront the two hypotheses. The ASR database is permanently available in a Blackboard VLE version 6.0 or higher, this means that other independent VLEs will probably have ways to collate similar datasets. This was very important because we wanted to collect equivalent logging data from many institutions to conduct our quantitative study in our search for general patterns.

We wanted to collect courses with and without executed actions of students. In other words, we wanted both courses that were initiated but rarely used and actively used courses. We will called such active courses '*online learning courses*' (OLC). In conjunction with designating OLCs we wanted to find organizations or communities where members really executed actions. Such an organization we called a '*virtual community*' (VC). In order to collect OLC and VC data from the multiple institutions we had to organise the data collection procedure specifically. Because we were interested in the deviation of active courses and active communities versus all courses and communities we decided to collect the figures initiated from the *ACTIVITY_ACCUMULATOR* and the *COURSE_MAIN* tables to obtain the non-processed uses and the cumulative uses from the *SYSTEM_TRACKING* tables. We selected these variables from the ASR database to perform our study.

4.3.2 System's Indicators for Uses of VLE System

Our research sub question B deals with the connection between the historical timeline as discussed in Chapter 3 with the two hypotheses set out in Sections 1.4 and 2.5. Hypothesis 1 is aimed at the system level of the VLE, because the VLE is a course management system, the hypothesis is aimed at determining the growth of facilitated VLE courses and its users. Consequently, we talk about the number of courses per institute over time. We called this the implementation grade, which was expressed in numbers of courses from the first to a theoretical maximum. This allowed us to catch a growth pattern for the educational technology over time, which we then confronted with growth patterns taken from the corporate innovation theories, see Chapter 2. Hypothesis 2 is aimed at the users' level of the VLE. It deals with activities within the courses, and with teachers and students as core users who executed these actions.

The set of initial questions presented in Table 9 led to us to indicators for the system uses and the users' uses. In the following sections, we will explain how the related indicators concerning the system's level were retrieved from the Blackboard logging data. In section 4.3.3 we will explain how the related indicators concerning the users' level were retrieved from the Blackboard logging data. We used the structured query language (SQL) scripts to obtain the appropriate data.

4.3.2.1 Indicator Total Number of Communities (b1) and Courses (b2)

This first indicator seems straightforward, just the total number of courses set up in the Blackboard VLE. The totals are presented every day in the *BB_BB60_STATS.SYSTEM_TRACKING* table since the VLE went online. The total number of courses seemed to be a simple measure to use to indicate the growth of the uses of the VLE. However, it was a too simple measure because the number was made up of the total of set up courses in the VLE, including flaws: and there were more flaws than expected at first sight, because the current total number of courses also included summed totals from earlier versions than 6.x, where courses and communities were mixed in.

The Blackboard VLE handles a organization or community in exactly the same way as a course. The only difference between a course and a community is that the variable *SERVICE_LEVEL* in the *BB_BB60_STATS.COURSE_MAIN* table contains a flag which indicates a 'course' when appearing as an 'F' and a 'community' when appearing as a 'C', and there is a third category 'system' which is indicated with an 'S'. The total numbers of the three categories were needed to calculate the ratios for active online courses and active online communities, which are described in the next section.
We selected the total number of courses from the *BB_BB60_STATS.COURSE_MAIN* table because it contained the same figures as the *SYSTEM_TRACKING* table, but figures were non-cumulated and non-processed.

4.3.2.2 Indicator Virtual Community (b3) and Online Learning Course (b4)

Next we wanted to know the number of courses and communities in which students enrolled and executed actions. In the *BB_BB60_STATS. SYSTEM_TRACKING* table from version 6.x and higher the number of courses and the number of active courses, meaning that activities had taken place within the last 30 days, were listed. We introduced the term online learning course (OLC) to indicate if a course was active with activities taking place over its lifespan and not only for the last 30 days. An OLC was defined as a course in which, at least, activities of students occured in conjunction with activities carried out by the instructor. We introduced the term virtual community (VC) for organisations to denote communities that contain student activities.

We used the *BB_BB60_STATS.ACTIVITY_ACCUMULATOR* to determine courses with active users and logged actions from system and users. System actions where no user's activities were found (null) were filtered out. We derived the course totals and community totals from the *BB_BB60_STATS.COURSE_MAIN* table to calculate the ratios. The user was determined by combining multiple tables concerning the user's role *BB_BB60_STATS.USERS.INSTITUTION_ROLES_PK1,* the users' variable *BB_BB60_STATS.ACTIVITY_ACCUMULATOR.USER_PK1* and the course identifier *BB_BB60_STATS.USERS.COURSE_MAIN.SERVICE_LEVEL* for a course (F) or community (C). The Blackboard VLE used multiple tables to designate the available roles for the system. We focused on the

INSTITUTION_ROLES using the value ‘1’ to indicate the student and on the *INSTITUTION_ROLES* using values ‘2’ and ‘3’ for respectively faculty and staff.

We divided both the courses and communities of the Blackboard VLE into two subcategories for our explorative study. The four categories were:

- OLC0 is the *non-course* with one or more active instructor(s) but no active students
- VC0, is the *non-community* with one or more active organisation leader(s) but no active members
- OLC is an *online learning course* with one or more active instructors and one or more active students
- VC is a *virtual community* with one or more active organisation leaders and one or more active members

4.3.2.3 Indicator Ratio for VC (b5) or OLC (b6)

We introduced the ratio indicator because the courses and communities without students and members do not only have negative meaning. Such ‘empty’ courses and communities indicate try-outs, first explorations, frustrations, and the like. To calculate the ratios between the active courses and the total number of courses and communities we used the OLC and VC numbers versus the totals taken from the *BB_BB60_STATS.COURSE_MAIN* table.

4.3.2.4 Indicator Lifespan Period for VC (b7) or OLC (b8)

The lifespan period gives a measure for the duration of a course in months, to calculate the lifespan in months we used the *DTCREATED* from the *BB_BB60_STATS.COURSE_MAIN* table as initiation date and the *DTMODIFIED* from the same table to determine the very last action of a course.

4.3.2.5 Indicator Number of Users for VC (c1, c3) or OLC (c2, c4)

We took this indicator to specify the growth of the number of users over time. Where the number of courses indicates the growth of the VLE on the system’s level (Nolan & Gibson, 1974) the number of users indicates the diffusion on the system’s level (Rogers, 2003). We took the *INSTITUTION_ROLES* from the *BB_BB60_STATS.SYSTEM_TRACKING* table.

4.3.2.6 Conclusion for System’s Indicators

The indicators for the VLE system’s uses concerning growth and diffusion are retrievable from the logging data.

The result of our explorative investigation was that we could resolve the normally unapproachable raw logging data and that we could convert them into figures to get indicators that could be used to represent the growth and diffusion of the Blackboard VLE. We used the indicators for our study to search for patterns in the Blackboard VLE system uses to test our first hypothesis.

4.3.3 Users' Indicators for Educational Uses

We used the seat time indicators of Table 9 to describe in which way the VLE was put to work by its participants and to present the uses of the teacher and student. The indicators taken together give a picture of how teachers and students use the VLE in their practice.

We will present the indicators for the users' uses in the following sections, which we derived from the raw data. We collected the data using SQL scripts, and addressed three indicators, seat time duration, seat time moment and seat time activities.

4.3.3.1 Indicator Seat Time Duration (c5, c6)

The seat time duration or session period is the time that a user, or better said an end-user machine, is connected to the Blackboard application server. Every time a user is connected to the VLE a session is set up to log the activities during that session including timestamps. After the last activity the session is disconnected either by the user logging out or by the system breaking the connection when idle for 3 hours. In our analysis we left out the time after the last logged activity.

The seat time duration of the online connection was derived from the session number *BB_BB60_STATS.ACTIVITY_ACCUMULATOR.SESSION_ID* and the timestamps of the first and last action of that session *BB_BB60_STATS.ACTIVITY_ACCUMULATOR.TIMESTAMP*. The seat time duration might indicate the endurance of the user when one takes into account the activities carried out during that session. Short seat time duration may indicate zapping behaviour or just reading messages such as announcements and last minute information. A longer seat time duration may indicate content studying by the student or course building if the user is an instructor.

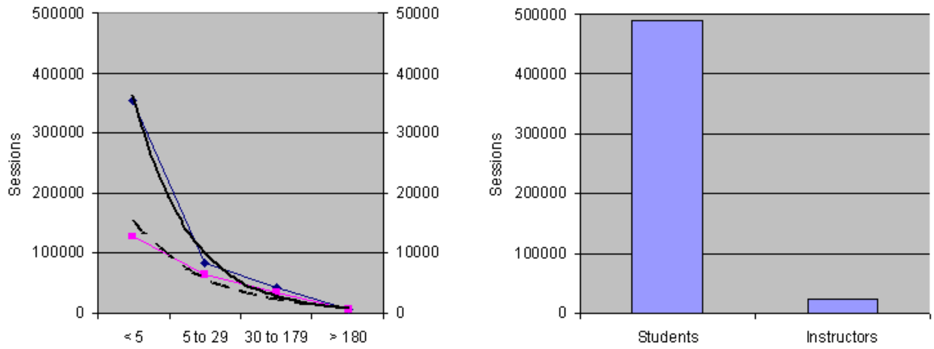


Figure 26: Illustrative Example of Seat Time Duration Distribution

An illustrative example of the distribution of the seat time duration is shown in Figure 26. We collected the seat time durations from students and instructors over a ten-month period. Two trend lines are shown in the figure on the left, based on a few arbitrarily taken samples. The left scale and continuous graph indicate the students and the right scale and dotted graph indicate the instructors. The number of counted sessions for students and instructors are shown in the figure on the right.

The presented sample was only used to gain insight into the distribution of the seat time duration. The trend lines indicate that activities with shorter durations were far more present then activities with longer durations. The right hand figure shows the ratio between the number of student sessions and the number of instructor sessions.

4.3.3.2 Indicator Seat Time Moment (c7, c8)

The point-of-time or moment-of-the-day of use told us something about the type of uses. Therefore the second indicator became the '*seat time moment*'. We wondered if we could explore when VLE users started their sessions and we wanted to know how sessions were distributed over the 24-hour working day.

An illustrative example is presented in Figure 27 for the distribution of the seat time moment. The sessions were categorised by the seat time moment as start of their online sessions from 0:00 to 23:00 hours. The sessions are subdivided into the user student, indicated by the continuous line, and instructor, indicated by the dotted line. The sample was taken over a 10 months period.

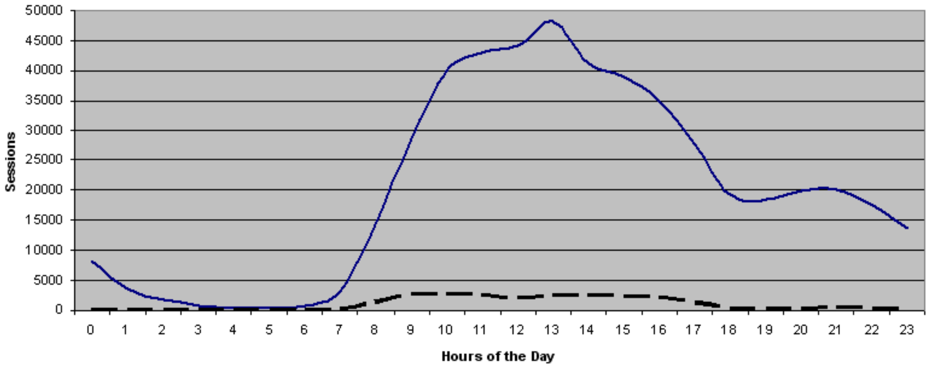


Figure 27: Illustrative Example of Seat Time Moment Distribution

The sample presented only allowed us to gain insight into the distribution of the seat time moment but it seemed that most students log on in office hours and a part of them continue to log on and use the system late into the night. There appeared to be a maximum around the midday break. The instructors mostly concentrated their work periods within office hours.

4.3.3.3 Indicator Seat Time Activities (c9, c10)

We introduced seat time activities as third indicator. When a user is connected to the Blackboard VLE all activities during the session are logged with a timestamp per action. The different activities could be derived from the *BB_BB60_STATS. ACTIVITY_ACCUMULATOR.INTERNAL_HANDLE*, which corresponded to one out of 402 unique ID's (*PK1*) from the *BB_BB60_STATS.NAVIGATION_ITEM* table, however, not all the undertaken actions corresponded to a navigation item and therefore sometimes this field was blank (null). When the field was empty then sometimes the prefix of the path the user took in the VLE could help such as '*CP_*', which indicated that the user had been going through the course control panel.

About 155 of the 402 different handles from the *BB_BB60_STATS. NAVIGATION_ITEM* table are directly related to one of the 32 predefined Blackboard applications for uses by student, instructor, or administrator, as presented in Table 13. Non standard but additional plugin 'building blocks' for a VLE system automatically set new handles during the installation process. At the time of our investigation the DUT case contained five of such additional plugin handles, which we ignored for equivalence reasons because of our multiple cases data collection. The remaining 242 handles are system and administration activities. The complete list of 402 handles is presented in Appendix D.

The 32 applications from the *BB_BB60_STATS.APPLICATION.NAME* table are listed in Table 13. We investigated the handle numbers of *BB_BB60_STATS. NAVIGATION_ITEM.PK1* and assigned them to a student or community member, instructor or leader, and a system administrator. The complete list of applications is presented in Appendix E.

Table 13: Internal System Handles with Relations to Blackboard Applications and Users

#	Application	Student or Member	Instructor or Leader	Administrator
1	academic_resources			324
2	address_book	24, 27-29, 214		
3	admin			325
4	announcements	2, 138-139	151	59
5	bb-glossary			423-424
6	calendar	18, 209	152	65
7	chalkbox			
8	chalkcourse			
9	collaboration	141	171	
10	community	5		322
11	content	6	7, 224-227, 384-385	
12	course_communications	10		
13	course_email	22, 140, 367-374	162, 289-296	
14	course_roster	142		
15	course_tools_area	11		
16	courses	321		
17	discussion_board	144-145, 297-298	165	
18	dropbox	206	172	
19	edit_homepage	207		
20	electric_blackboard	213		
21	groups	125-128, 143, 300	173, 274-278,279	
22	instructor_gradebook		167-168, 240-270	
23	manual	211		
24	messages	425	426	
25	observer			98, 342-344
26	observer_tools			194, 345-347
27	personal_info	17, 25, 208, 316-320, 337-341, 362-366		30-33, 46, 48, 78-79
28	resources	19	183	
29	services	323		
30	staff_information	195	156	
31	student_gradebook	21, 210		
32	tasks	20, 212	157	

To indicate educational uses from the VLE and its seat time activities we focused on the applications, used by teacher and student. Some applications take more or less the same educational direction, hence we articulated five distinctive types of uses: course-oriented, community-oriented, presentation, messaging and tooling. The presented text box hereunder describes the marked applications from Table 13 and the marked internal handles to which they refer. The non-marked applications and handles were ignored because they could be used by system administrators or because we could not find any relation to educational uses. The seat time activities indicate which actions were undertaken during a session by the student or instructor, how much time the activities took, and in which order they were done.

Course-oriented: *these are activities which are typically related to online courses.*
Content area: *the content area stores subject matter online (cp_content - handle 7).*
Tasks: *the instructor provides students with tasks (cp_tasks - handle 157).*
Resources: *the instructor makes papers, readers, or other references available online with files or URLs (cp_academic_web_button - handle 183).*
Grade book: *the grade book contains application handles for the instructor to place them (cp_gradebook - handle 167) and for the student to view them (check_grade - handle 210).*
Dropbox: *the digital drop box allows students to exchange files with the instructor. The uses of this tool are initiated with the cp_digital_dropbox - handle 172.*
Groups: *students can be organised in groups for having their own discussion boards, shared files, chat sessions, documents, et cetera. With cp_add_group - handle 278 the group forming is initiated.*

Community-oriented: *these are activities which are typically related to online communities.*
Discussion board: *the discussion board is an asynchronous communication tool. With the actions cp_discussion_board - handle 165, db_message - handle 297 and db_post_message - handle 298, the 'sending*

activities' can be activated. With the action discussion_board_entry - handle 144 a reaction or response can be threaded, and with discussion_board - handle 145 one just reads the message.
Community: *users can access communities when they list them with community_pages - handle 5.*
Communications: *with course_communications - handle 10 the student intends to use communications.*

Presentation: *these are possibilities for the student or member or instructor to present themselves ('Who-am-I') and to look for (classroom or group) mates ('Who-are-my-peers').*
Address book: *users store contact information in the address book. The address book remains empty until a first contact is entered. Users fill in a profile with ab_add_contact – handle.*
Staff Information: *the site where the instructors introduce themselves with descriptions of their affirmation and curriculum vitae (cp_staff_information - handle 156 and staff_information - handle 195).*
Personal information: *users can update their personal profile with personal_info - handle 208.*
Student home page: *students are allowed to have their own home pages with edit_homepage - handle 207.*

Messaging: *instructors inform students with announcements at the course sites or sending messages to selected persons or groups.*
Announcements: *when a student logs in and browses to a course than automatically the first page presented is the announcement page (handle 2), hence, we may assume that not an extra action is needed from the student (which is possible) to read announcements. The instructor initiates new announcements with cp_announcements - handle 151.*
Email: *users may send emails with cp_send_email - handle 162.*

Tooling: *these are functionalities for easy handling.*
Course tools area: *access to the course tools area indicates a search for a certain tool with course_tools_area - handle 11.*
Roster: *students get information about members or peers of their course from the roster. When they look up their peers the student_roster – handle 142 is used.*
Collaboration: *users manage and enter collaboration sessions with cp_collaboration - handle 171 and or collaboration - handle 141.*
Electric blackboard: *the electric blackboard allows users to save notes for a course with electric_blackboard - handle 213.*
Calendar: *the student is expected to visit the calendar after being triggered by the instructor (be it oral or virtual). Calendar functions are initiated with cp_course_calendar - handle 152.*
Messages: *discussion board messages are administered with the messages_manager - handle 426.*
Manual: *if help is needed to use the VLE (student_manual - handle 211).*

4.3.3.4 Conclusion for User's Indicators

The indicators for the VLE users' uses concerning duration, moment and activity are retrievable from the logging data.

We explored the DUT Blackboard VLE looking for logging data, which had a direct or indirect relation with the uses of the teacher or student. The purpose of the exploration was to determine if such empirical data could be revealed using the normally unapproachable logging data. The exploration delivered us three indicators for the educational uses:

- seat time duration, used to indicate the session length
- seat time moment, used to indicate the start time of the session
- seat time activities, used to hold the activities executed during the session

The result of our explorative investigation was that we could relate the three educational uses to teachers and students for both course and community. If we projected these uses over time then we would be able to indicate changes in these activities to search for patterns, with respect to users' uses in order to test hypothesis 2.

4.4 MULTI-CASE DATA COLLECTION

Yin (1994) has pointed out that the generalisation of results is made for theory only and not for populations in general. This means that case studies cannot represent entire populations, nor do they claim to (Yin, 1994). Of course, we were aware of this, having in mind that, for our research, we were limited to the Blackboard VLE. Still, to strive for more robust results we decided to collect multiple datasets to look for general, possible patterns and rules, which we could compare with the innovation theories as presented in Chapter 2.

For reasons of robust data analysis, our multiple cases had to follow some sort of replication to obtain compatible and corresponding data, this is called *equivalence*. Equivalence is an important issue when conducting multiple case studies, because we needed to compare similar data for all our cases (Goedegebuure & Vught, 1994). To be certain to measure equivalent data from different cases we took the virtual learning environment Blackboard as our fixed variable. Consequently, we excluded other VLEs such as ClassCampus, COSE, FirstClass, LearningSpace, TeleTop, TopClass, WebCT and others. We focussed on the ASR database and collected similar datasets from different institutions to promote equivalence of data. *Independence* is another important issue for the generalisation of theories, and we therefore solicited a large number of international higher education institutes for data.
Multiple cases require two stages of analysis, the within-case and the cross-case analysis. In the within-case design the case is treated as single unit, and the data is analysed within the situation of the case. For the within-case we restricted ourselves to the empirical data of the Blackboard VLE, as described above in the pilot case study. We used cross-case analysis to find conclusive relations, abstractions, and possibilities to test hypotheses 1 and 2. This is described in Chapter 5.

In order to conduct a valid and reliable cross-case analysis we had to collect enough datasets. Since we had to obtain such datasets from other institutions this meant tremendous amounts of data were collected. Therefore, we reduced the required datasets in advance. Data reduction is a process of selecting, focusing, simplifying, abstracting and transforming raw data. According to Yin (2003) data reduction is not something separate from analysis; it is part of analysis. Consequently, we intertwined our within-case analysis of the DUT case study with the data selection process to determine which data had to be collected, and we designed collection queries to facilitate the data collection process to obtain equal datasets from many institutions.

4.4.1 Multi-Case Data Collection Queries

We had to contact system administrators or officers in charge of Blackboard VLEs from multiple institutions to acquire the necessary empirical data. We explained how we connected to the database without violating privacy regulations in Section 4.3.1 and this allowed us to avoid out-drawn permission procedures. We only had to design simple data collection procedures to facilitate the collection process at other institutions. We contacted the system administrators by using an email that held a memorandum and explained how the data acquisition would take if they permitted it.

The data collection queries were set up in such a way that the VLE system administrators easily could set their systems to do the work and no privacy regulations were violated. The data were obtained in flat textual formats and had to be stored in datasets holding six files each. The processing of obtained datasets took place after collection to save server load and processor time at the acquired institute. Every collection query was explained for use and for its goal within the memorandum. Moreover, the estimated collection time per query was given to give the system administrator an indication of the processing capacity required from their production servers. Zipping the collected text files afterwards reduced the size of the datasets by a factor of 15 to 20. In the end, we received the datasets as non-processed text files.
Sometimes the *STATS* database was not used within an institution's system. To run the collection query in such a case, one simply had to remove the "_stats" part (e.g. *BB_BB60_stats* becomes *BB_BB60*). To indicate what data was collected by the queries, examples of the textual content were displayed in the sent memorandum.

The six data collection queries are presented in the following sections and described for querying Oracle databases. The queries for processing MS SQL databases are shown in Appendix F.

4.4.1.1 Query SystemRegistry.sql (d1, d2, d4, d5)

This query was designed to distinguish the proprietor or dataset owner. It was derived from the original database *BB_BB60*. We wanted permission from the proprietor to use the fields for institution type casting and geographical matters. After the acquisition we found that the institute data fields had been removed, hence, no diffusion patterns could be revealed from geographical data. The query was presented in Script 1 (Estimated time: < 1 second. Size: 0,05 Mb):

Script 1: SQL of SystemRegistry.sql

```
Select
trim(registry_key)||','||trim(registry_value)
from bb_bb60.system_registry
;
```

Example of results:

install_date	16-7-2004
institution_type	higher education
register_city	Delft (REMOVED)
register_country	Netherlands (REMOVED)
register_name	Technische Universiteit Delft (REMOVED)
register_state	NA (REMOVED)
register_zip	2600AA (REMOVED)
release_number	6.2.3.19

Possible growth pattern:

- Number of institutions, (inter)national sample size
- Type of institutions, nominal sample type; higher education, further education, K12, corporation
- Number of countries, not available
- Number of institutions per country, not available

Possible diffusion pattern:

- Geographical spread per country, state, and zip, not available
- Geographical diffusion, not available
- Period of use over version and release number, install-date to date

4.4.1.2 Query CourseMain.sql (b1 – b8, d3)

This query was set to obtain an overview of the courses and communities of an institute with their creation dates and last working dates. This data was very important for testing our 1st hypothesis. The query is presented in Script 2 (Estimated time: < 1 second. Size: 1 Mb):

Script 2: SQL of CourseMain.sql

```
Select
pk1||','||classifications_pk1||','||to_char(dtcreated,'YYYY-MM-DD')||'T'||
to_char(dtcreated,'HH24:MI:SS')||','||to_char(dtcreated,'YYYY-MM-DD')||'
'||to_char(dtcreated,'HH24:MI:SS')||','||to_char(dtmodified,'YYYY-MM-DD')||
'T'||to_char(dtmodified,'HH24:MI:SS')||','||to_char(dtmodified,'YYYY-MM-DD')||'
'||to_char(dtmodified,'HH24:MI:SS')||','||trim(service_level)
from bb_bb60_stats.course_main
;
```

Example of results:

PK1	CLASSIFICATIONS_PK1	DTCREATED	DTMODIFIED	SERVICE_LEVEL

3232	107	14-3-2001 0:00	13-4-2005 12:44	F
3234	162	15-3-2001 0:00	16-11-2004 10:11	F
3235	116	15-3-2001 0:00	16-7-2004 21:22	F
3272	107	21-8-2001 7:44	7-3-2005 13:00	C

Possible growth pattern:

- Number of courses and non-courses
- Course type or profession, according to Bb classification
- Lifespan period of the course
- Number of communities and non-communities
- Community type or profession, according to Bb classification
- Lifespan period of the community

4.4.1.3 Query Handle.sql (c1 – c4, c9 – c10)

The seat time indicators of the users' uses within the VLE were collected for answering our 2nd hypothesis with this query. From the actions from the users we wanted to derive characteristics and possible changes of such characteristics over time. The *BB_BB60_STATS.ACTIVITY_ACCUMULATOR* presents every action taken in Blackboard, and can be assumed to be data logger. Out of the 402 internal handles 28 handles were selected to indicate uses of the applications within the VLE. The query is presented in Script 3 (Estimated time: 30 minutes. Size: 800 Mb):

Script 3: SQL of Handle.sql

```
Select
aa.COURSE_PK1||','||aa.USER_PK1||','||u.INSTITUTION_ROLES_PK1||','||
aa.SESSION_ID||','||to_char(aa.timestamp,'YYYY-MM-DD')||'T'||
to_char(aa.timestamp,'HH24:MI:SS')||','|| to_char(aa.timestamp,'DD-MON-YYYY')||'
'||to_char(aa.timestamp,'HH24:MI:SS')||','||aa.INTERNAL_HANDLE
from
  bb_bb60_stats.activity_accumulator aa,
  bb_bb60_stats.users u,
  bb_bb60_stats.course_main cm
where
  aa.USER_pk1 =  u.PK1
  and aa.COURSE_PK1 = cm.PK1
  and USER_PK1 is not null
  and COURSE_PK1 is not null
  and USER_PK1 <> 6
  and INTERNAL_HANDLE in (
  'cp_announcements','cp_course_calendar','cp_staff_information',
  'cp_gradebook','cp_academic_web_button','staff_information',
  'check_grade','student_manual','ab_add_contact','student_roster',
  'personal_info','edit_homepage','cp_collaboration','collaboration',
  'course_tools_area','cp_digital_dropbox','electric_blackboard',
  'cp_add_group','course_communications','cp_discussion_board',
  'db_message','db_post_message','discussion_board_entry',
  'discussion_board','cp_send_email','messages_manager','cp_content',
  'cp_tasks')
group by
  course_pk1,
  user_pk1,
  institution_roles_pk1,
  session_id,
  timestamp,
  internal_handle
;
```

Example of results:

COURSE_PK1	USER_PK1	INSTITUTION_ROLES_PK1	SESSION_ID	TIMESTAMP	INTERNAL_HANDLE
2194	176076	20	54	22-7-2004 8:40	cp_announcements
2205	163075	1	47450	1-8-2004 0:04	discussion_board_entry
2205	163075	1	47450	1-8-2004 0:04	collaboration

2207	131424	2	196785	24-8-2004 10:53	cp_announcements
2207	151724	1	16531	26-7-2004 7:21	staff_information
2208	142743	1	474259	11-9-2004 12:45	course_tools_area
2217	174400	1	217652	26-8-2004 15:53	staff_information
2217	174400	1	404434	7-9-2004 21:45	course_tools_area
2217	175500	1	232517	28-8-2004 19:43	check_grade
2217	134066	1	12272	24-7-2004 23:39	course_tools_area
2217	134066	1	398022	7-9-2004 16:46	course_tools_area
2217	135052	2	147055	17-8-2004 14:22	cp_content

Possible use pattern (which application at which time) per user (student, faculty, staff) per course or community (per institute and type):

- Active users per course and community
- User roles per course, community, student, faculty, staff
- Used applications per course or community, out of 28 actions

4.4.1.4 Query Duration.sql (c5 – c8)

The session period or seat time duration is the time an end-user machine or client is connected to the Blackboard application server. The query is presented in Script 4 (Estimated time: 20 minutes. Size: 500 Mb):

Script 4: SQL of Duration.sql

```
select
  session_id||','||round((max(timestamp) - min(timestamp)) *24 *60)
  from
  bb_bb60_stats.activity_accumulator
  where
  session_id > 1
  group by
  session_id
;
```

Possible seat time pattern:

- Seat time duration, per user, per course or community
- Seat time moment, per user, per course or community

4.4.1.5 Query SystemTracking.sql

This query was used to obtain the Blackboard's own system tracking files to check the cumulated figures of the VLE with the collected data of CourseMain. The system administrator uses this SystemTracking table to generate the management reports. The original system tracking data were compared with the derived figures from the CourseMain and Handle tables to discern the non-courses and active courses (OLC), and the non-communities and active communities (VC). The query is presented in Script 5 (Estimated time: < 1 second. Size: 1 Mb):

Script 5: SQL of SystemTracking.sql

```
  Select
  to_char(timestamp,'YYYY-MM-DD')||'T'||to_char(timestamp,'HH24:MI:SS')||',
  '||to_char(timestamp,'DD-MON-YYYY')||','||to_char(timestamp,'HH24:MI:SS')||',
  '||courses||','||organizations||','||users||','||course_users_p||',
  '||course_users_s||','||page_views
  from bb_bb60_stats.system_tracking
  ;
```

Example of results:

TIMESTAMP	COURSES	ORGANIZATIONS	USERS	COURSE_USERS_P	COURSE_USERS_S	PAGE_VIEWS
3-9-2004 1:00	2413	272	48060	2604	36660	128593

4-9-2004 1:00	2426	273	48096	2605	36892	141356
5-9-2004 1:00	2430	274	48122	2606	36930	130622
6-9-2004 1:00	2430	274	48122	2605	36963	167503
7-9-2004 1:05	2431	274	48121	2611	37014	196630
8-9-2004 1:00	2433	275	48199	2614	37138	312392
9-9-2004 1:00	2451	276	48278	2618	37357	392382

Blackboard statistics (per institute, per institute type):

- Days of use
- Total courses since start date
- Total communities since start date
- Total users since start date
- Total instructors since start date
- Total students since start date
- Total page views since start date

4.4.1.6 Query Plugins.sql

We wanted to determine which plug-ins or building blocks were installed in a particular Blackboard version to know what additional features were operational next to the standard Blackboard VLE application.

The query is presented in Script 6 (Estimated time: < 1 second. Size: 0,005 Mb):

Script 6: SQL of Plugins.sql

```
Select
plugins_pk1||','||trim(application)||','||trim(label)||','||trim(type)||',
'||trim(name)
from bb_bb60_stats.application
where plugins_pk1 is not null
;
```

Example of results:

#	PLUGINS_PK1	APPLICATION	LABEL	TYPE	NAME
1	13	FSU-adv-grp-mgmt	Advanced Group Managment	SHARED	Advanced Group Managment
2	14	sen-senwhosonline	Who's Online	SYSTEM	Who's Online
3	57	dto-emerge-tools	E-merge tools	SHARED	E-merge tools
4	65	DTO-alumni	Alumni edit/search tool	SYSTEM	Alumni edit/search tool
5	72	bb-cntplayer	Blackboard Content Player	SHARED	Blackboard Content Player
6	92	lttM-enrollstaff	Add Users by Role	COURSE	Add Users by Role
7	93	dto-richlink	Rich URL	SHARED	Rich URL

Applied plug-ins:

- Number of plug-ins per institute
- Types of applied plug-ins
- Distribution of plugins

4.4.1.7 Remarks

After some testing, the data collection queries could be easily set to work by the system administrators of the participating institutes, which was an acquired precondition before asking an institution's system administrator to cooperate in the project. As the data was collected anonymously, no records that contained personal data were queried. Most of the delivering institutes had also removed the proprietors or owner names from the data, which ruled out any determination of geographical diffusion as proposed in the SystemRegistry.sql query from section 4.6.1.
Again due to the need for anonymity we could not select on course names or professions and had to aim at the classification numbers of the courses. Consequently, we had to search for alternatives to investigate

probable patterns for diffusion. It appeared that only an increase in users following Rogers (2003) remained for checking the diffusion figures. The install_date and institution_type remained in place for discerning the lifespan of the VLE and the several types of institutions.

4.5 Results of Data Collection Phase

Anonymous logging data from 293 institutes were collected in packed datasets of six files, each containing data in a textual format. After the codification and storage of the raw datasets a qualification process took place. Using a text editor that could handle 'regular expression' functionality all the 1758 textual files collected were screened for incomplete records and typing errors. The cleansing process took about two months and then we imported the processed data into a MSSQL database to support the data analysis phase, presented in Chapter 5. Using the 'research base' at our own database server, we were able to quest the logging data at our convenience. This freed us from organisational and administrative procedures, and we did not have to submit any more permission requests to approach the research data.

4.5.1 Results of Quantitative Data Collection

Of the 293 collected datasets unfortunately 4 datasets were damaged and could not be used to answer the 1st hypothesis. A majority of 223 datasets had all of the queries, containing the textual data, asked for. Unfortunately, 66 datasets missed the activity logs of the Handle query and could not be used for the analysis concerning the 2nd hypothesis.

I - Using the **SystemRegistry.sql** query four types of institutes were derived which were catched under the InstituteClass. The InstituteClass, recorded within the SystemRegistry, showed us that 27 of the datasets were K12 institutes, 14 were further education institutes, 236 were higher education, and 12 were corporations. We focussed on the datasets from higher education only for the confrontation with the hypotheses.

The install dates of the current installation or application version were registered in the SystemRegistry, however, earlier versions of the installed VLE were not mentioned. If we wanted to know the date when an institution initially started with presenting their first online courses, we had to take the date from the very first course of the corresponding *COURSE_MAIN* table with its 'first timestamp'. A summary of the start dates for the several institutions based on the first timestamps of courses is given in Table 14.

Table 14: Starting Year for InstituteClasses over Sample Period

Year	K12	Further Education	Higher Education	Corporate	Total
1999	0	0	22	0	22
2000	4	3	45	1	53
2001	2	0	41	1	44
2002	4	2	17	3	26
2003	10	2	21	2	35
2004	3	1	17	1	22
2005	1	6	58	1	66
2006	3	0	15	3	21
	27	**14**	**236**	**12**	**289**

A complete overview of every institute with its first timestamp is given in Appendix G, where the institutes are presented using an anonymous owner name, by institution type, total of courses, an indication if activities were logged, installation dates, first and last timestamps, and their lifespan period for use of Blackboard VLE.

II - A total of 1,277,276 course-IDs were declared for the **CourseMain.sql** query of which 1,252,766 were courses with the attribute ServiceLevel 'F', 24,224 were communities with ServiceLevel 'C', and 286 were test courses for administrators, denoted ServiceLevel 'S'. We ignored the ServiceLevel 'S'. We followed the classification schema of the Blackboard VLE to divide the courses 'F' and communities 'C' into course classes or rather professions. This schema holds 250 different course classes, such as biology, chemistry, aerospace engineering, calculus, etcetera. We collected 238 different course classes. The complete overview of the CourseClass is listed in Appendix H. It was striking that higher education accounted for about 90 percent of the more than 1.27 million collected courses. After inquiry, the probable reason for this was that over the years automatic course generation systems had been introduced by the system administrators. A small-scale interview with eight system administrators corroborated with this assumption. The CourseClass value, recognised by the system administrators as InstituteClass, was no longer set when the courses were automatically generated, meaning that the initial CourseClass value remained by default on higher education. In the early years of the Blackboard VLE that default value was set neatly to the corresponding CourseClass, but this was mostly done by the teachers as they developed a new course. Once automated course generation was introduced this choice was lost, however, the value can still be edited.

Table 15: Overview of ScienceClasses and CourseClasses

ScienceClass	General science	Arts & Humanities	Natural Sciences	Engineering	Social Sciences	Totals
CourseClass	18	47	44	28	101	238
Courses	2,940	12,815	22,674	15,201	1,223,646	1,277,276

We have made an additional classification assignment for the collected courses and communities. A distinction was made into science classes, which followed the class assignment that libraries applied to index their scientific catalogue, such as the National Library of the Netherlands (National Library, 2006) and the Open University of the United Kingdom. The 238 professions assigned as CourseClass were assigned to 5 ScienceClasses of which 18 professions were assigned to general sciences, 47 to arts & humanities, 44 to natural sciences, 28 to engineering, and 101 to social sciences. Subsequently the courses and communities were subdivided into 2,940 to general sciences, 12,815 to arts & humanities, 22,674 to natural sciences, 15,201 to engineering, and 1,223,646 to social sciences. The complete overview of the CourseClasses and their corresponding ScienceClasses is listed in Appendix I.

III - The application calls of the users within the courses and communities were collected with the **Handle.sql** query. There were 113,352,919 educational activities conducted by 6,895,992 users. Using the collected handles the next 23 were called:

```
'ab_add_contact'        'check_grade'              'collaboration'
'course_tools_area'     'cp_academic_web_button'   'cp_add_group'
'cp_announcements'      'cp_collaboration'         'cp_content'
'cp_digital_dropbox'    'cp_discussion_board'      'cp_gradebook'
'cp_send_email'         'cp_staff_information'     'cp_tasks'
'discussion_board'      'discussion_board_entry'   'edit_homepage'
'electric_blackboard'   'personal_info'            'messages_manager'
'staff_information'     'student_roster'
```

The following handles were not called within the collected logging data:

```
'course_communications'  'cp_course_calendar'   'db_message'
'db_post_message'        'student_manual'       'community_pages'
```

Of the 20 possible 'roles' we focussed on the student and instructor. The *COURSE_USERS* table was delivered empty to maintain privacy, consequently we had to derive these roles from the *INSTITUTION_ROLES* table. Unfortunately, there was no easy 'S' for student and 'P' for instructor present in that table. Consequently, the teacher's role was delineated using a combination of the two institution_roles 'staff' and 'faculty'. Even after the investigation it was not clear when one or the other role was applied; both carried the instructor handles used, thus we processed faculty and staff separately as two parts of the role instructor.
Other users such as alumni, prospective students, guests, other and observer were ignored and only considered when further investigation was appropriate. The remaining assigned institution roles were used rarely giving dispersed data that could not be used to give a reliable analysis, thus we left these data out of our analysis.

IV - In response to the **Duration.sql** query 88,637,021 different sessions were collected of which 6,887,722 sessions held the more than 113 million educational activities or handles from the Handle.sql query. The other 81,749,299 sessions held system handles for administration, maintenance, or the like, and were not considered for our study.

V - The cumulative figures of the VLE's statistics were collected with the **SystemTracking.sql** query. The statistics held figures for courses, communities, users, and page views. We have collected 289,932 records, which were considered to check the growth figures for 1st hypothesis.

VI - With the **Plugins.sql** query we collected 842 different plug-in applications or building blocks. We ignored them for our study because the distribution appeared to be skewed in respect to our collection samples.

4.5.2 Research Base as SandBox for Multiple Collected Datasets

The datasets were tracked for incomplete records, broken or interrupted data fields and wrongly converted keywords. Thereafter, the 289 datasets were loaded into a Microsoft SQL database, which was set to work as our research base or 'sandbox'. We created an automated import process, transferring the processed data into the defined tables of our research base. In the end, our research base held nearly 25 Gigabyte (24,047.88 Megabyte) of textual data.

The defined tables of our research base are 'CourseClass', 'CourseMain' and 'ServiceLevel' aimed at courses and 'Handle', 'UserRole' and 'Duration' aimed at uses. We have added the table 'ScienceClass' to assign the CourseClasses to ScienceClasses. The tables 'SystemRegistry', 'SystemTracking' and 'Plugins' were used for general assignments. The table 'InstitutionTimes' with converted derivatives from several other tables were used to support the conversion from calendar time to a lifespan axis. This gave a research base that contained 11 different tables, see Figure 28.

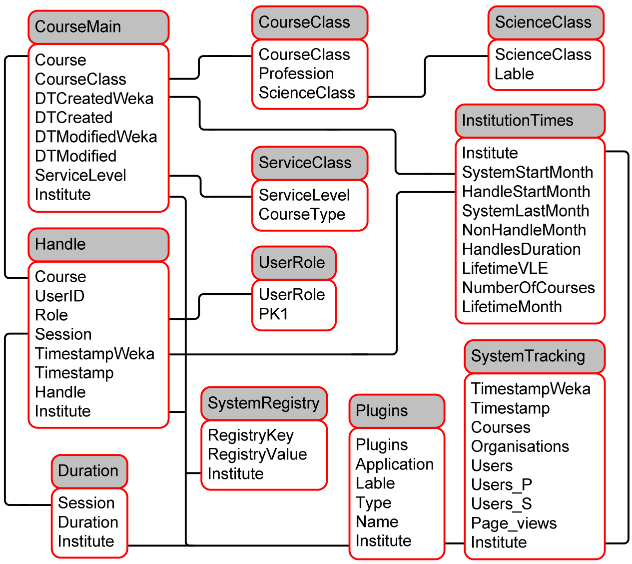


Figure 28: Research Base composed of 289 acquired Datasets of Blackboard Logging Data

Using the CourseMain table the lifespan of a course, its CourseClass, its ScienceClass, and its ServiceLevel can be discovered. Using the Handle table the course characteristics, the user's role, the type of action with its duration and the timestamp can be discovered. The InstitutionTimes table holds the start times for both the system with its first course and the first Handle timestamps. In order to determine in which system's lifespan month the handles were recorded. The SystemTracking table was the table the system administrator used to derive regular Blackboard system summaries. The SystemRegistry table was used to present the institute's type. The Plugins table was used for system configuration, this was not used as it fell outside the scope for this study and was skewed.

Taking into account all the subsets and the assignment to several classes we were able to set up a classification schema for all of the data built out off the 289 collected samples. The classification schema is presented in Figure 29.

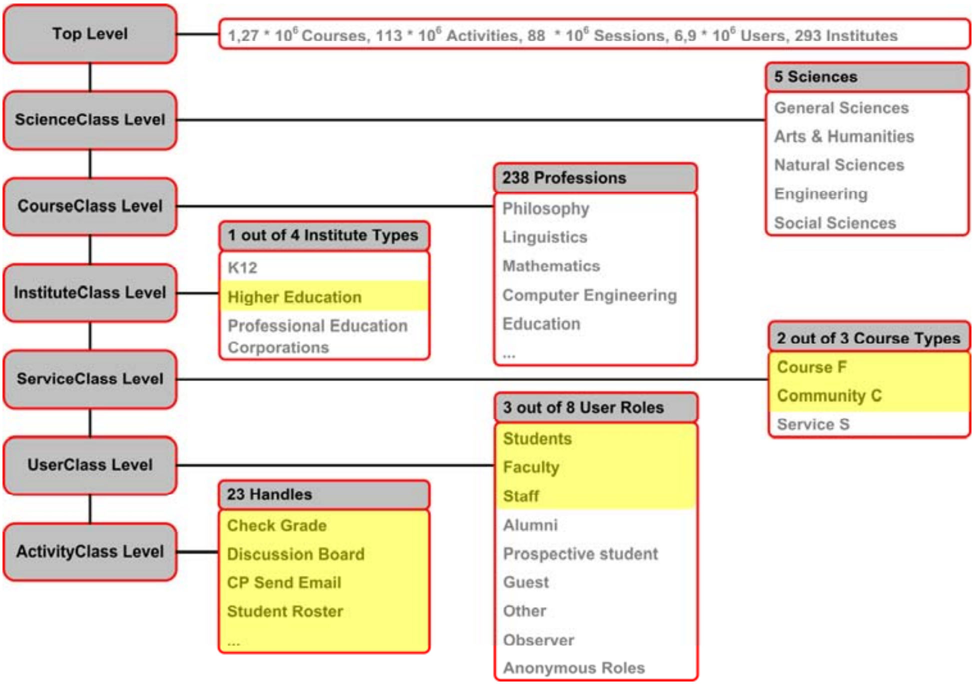


Figure 29: Classification Schema for the obtained Blackboard VLE Logging Data

We focussed on the ScienceClass level for our study, the CourseClass level, the InstituteClass level, and the ServiceClass level were used to answer the 1st hypothesis. To answer the 2nd hypothesis we focussed on 'higher education' from the InstituteClass Level, on Course 'F' and Community 'C' from the ServiceClass Level, on the roles 'student', 'faculty', and 'staff' from the UserClass Level, and on all the 23 Handles from the ActivityClass Level. The items used to answer for hypothesis 2 are marked in yellow.

4.6 SUMMARY

We chose the Blackboard VLE as our unit of analysis and the VLE from the Delft University of Technology (DUT) as an explorative case. We used a quantitative and qualitative approach for the DUT case study in order to construct empirical data for the system's uses and the users' uses in order to test the two hypotheses. The pilot case taught us that the, thus far apparently unapproachable, logging data could be used to obtain information. In the beginning there were some problems that had to be overcome, such as privacy regulations and multiple versions of the underlying VLE data architecture. Once the problems were dealt with, the aim we sought to determine was if relevant data were present within the logging data and if it was possible to structure the relevant logging items. The in-depth study showed that most of the data were independent system handles and user activities, however, relations could be distinguished between the system's handles and the users' activities, and these could be used to construct an image of the VLE system's uses and the users' uses. During this pre-processing phase we caught our first sight of how to construct and correct the figures. We also unravelled which system handles corresponded to which applications. Once the structure of the data was mapped we compared our initial questions with the possible to reveal data. This left us with several indicators for parts of raw logging data that we could use to represent the system's uses and the users' uses.

The qualitative data collection taught us that DUT teachers applied a mix of learning strategies. Active learning leads, both with ICT and without ICT tools, though the instructor-led lecture, instruction and individual coaching are still popular teaching activities. The DUT Blackboard VLE was used by more than 93 percent of the teachers, however, not all the VLE's functionalities were set to work. The features, which meet the need for efficiency and ease of use, were considered to be very important for the teachers, this is corroborated by another recent study (Tempelman, 2009).

In our search to find data to confront the two hypotheses we needed many equivalent cases to discover patterns in a valid and robust way. Consequently, we followed a quantitative approach. Our acquisition at other cases, or rather datasets of similar logging data, had to give enough data to cover valid conclusion drawing, but had to be a sample as small as possible because of the processing capacities required to handle very large amounts of data. We designed special data collection queries to acquire other case data. When acquiring the datasets from other institutions we were bound by the need to respect privacy and collect anonymous data to try to prevent an institute refusing to cooperate due to privacy regulations and to negate the need for additional permission from their legal departments. However, anonymously collected data meant non-contextual electronic messages and discussion threads, and no users' names. With respect to the electronic messages, we only knew that the message was sent, but not the content of the message. We knew that the discussion board was used, but not what was said. We knew that an application was used, but not the intention behind using it. Our final sample was the equivalent logging data from 289 institutes.

When we processed the obtained datasets we found that the email facilities of the VLE's were handled by external servers. Those servers were not related to the Blackboard VLE's and accordingly the email messages were not logged within the VLE database; The *INTERNAL_HANDLES* related to email were redirected to an external email server, for instance Microsoft Exchange, consequently, it appeared impossible to deduce message-patterns, which ruled out any social network analysis. The same counted for the communication patterns of the discussion boards from the original database *BB_BB60*. In the end we were not able to investigate any communication behaviour, indicator c11 and c12, which meant that we had to focus on Blackboard uses. Moreover, unexpectedly, no proprietor or owner names were found to be present. Although that particular query was aimed at the central VLE database and not at the ASR database it appeared that most of the owner names had been removed. No owner name meant that no diffusion patterns based on geographical spread could be discovered.

Despite the mentioned drawbacks we were still able to collect data that could be used to connect the historical timeline, discussed in Chapter 3, with the uses of the VLE on the system's level and the users' level. This resulted in the definition of several indicators, used to represent the system's uses and the users' uses. After the cleansing process the datasets were imported into the research base. In order to pinpoint the appropriate data for our study the obtained datasets were categorised in classes. We used data from the ScienceClass, CourseClass, InstituteClass, and ServiceClass for our study concerning hypothesis 1, and we used data from the higher education InstituteClass for our study concerning hypothesis 2 in combination with the data from ServiceClass 'F' and 'C', UserClass '1', '2', and '3', and all 23 'handles' from ActvityClass.

5 Descriptive and Test Analysis of VLE's Uses and Users' Uses

With a suddenness that startled them all, the wizard Gandalf sprang to his feet. He was laughing! "I have it!" he cried. "Of course, of course! Absurdly simple, like most riddles when you see the answer."

From The Fellowship, part 1 of the trilogy,
The Lord of the Rings
by J.R.R. Tolkien (Tolkien, 1954)

The data analysis for the collected datasets is described in this chapter. We followed a two-fold approach to test our two hypotheses. To test hypothesis 1 we analysed the ScienceClass level, CourseClass level, InstituteClass level and ServiceClass level. Although we conducted a descriptive analysis for all of the InstituteClasses, we will not present the figures for K-12, further education and corporations. This is because we restricted our test analysis to higher education. To test the 2nd hypothesis we analysed the subsets which contain the logging data for 'higher education' from the InstituteClass and that of the 'F' (course) and 'C' (community) from the ServiceClass, for '1' student and '2' faculty and '3' staff from the UserClass, and of all 23 activity handles from the ActivityClass.

We first conducted a descriptive analysis for the system's uses followed by a test analysis for hypotheses 1 to confront our findings with the theories of Nolan and Rogers, see Chapter 2. The next step was a descriptive analysis for the users' uses followed by a test analysis to confront our findings with the theory of DeSanctis and Poole, see Chapter 2, for hypotheses 2.

5.1 DESCRIPTIVE ANALYSIS FOR SYSTEM'S USES

We followed the proposed indicators as presented in Chapter 4 to present a structured overview of the system's uses. In selecting the appropriate data from the research base for the system's uses we designed scripts using SPSS (Statistical Package for Social Sciences) syntax to command the SPSS analysis tool. When this syntax is called by the SPSS tool it runs the exact steps as coded. This allowed us to trace and redo every step of our investigation. The syntax scripts can be found in Appendix K. In order to follow the same syntax as described one has to take care that the datetime values meet the ISO8601 standard for calling the correct substring parts, which is set in yyyy-mm-ddThh-mi-ss (24 hour) notation. To present regularly the amount of data on a time-axis we used the YearMonth format (yyyy-mm) to present our findings on a monthly basis. This monthly basis was useful for easier presentation of the data on the timeline, and for recoding and correcting the raw data. Sometimes we had to rearrange many subsets to compare them for the system's uses. An example of SPSS commands is shown in Script 7, it was used to connect and obtain the data from our research base. The '*GET DATA*' syntax was used for every call, hence this common syntax is given as example.

Script 7: Example of SPSS Syntax to Query the Research Base

```
* In order to present the Indicator ...
  we load the ... from the research base.
GET DATA
/TYPE=ODBC
/CONNECT='DSN=Pietzijndata;Description=BlackboardData;UID=;APP=SPSS       For       Windows;'+
'WSID=PHD_PIETZ;DATABASE=Pietzijndata;Trusted_Connection=Yes'
/SQL= " SELECT "
* Variables and Table names follow hereunder dependent on the search.
* ............................................................. .

* The different institutes are recoded into further education ... .
* ... to make a distribution over 4 InstituteClasses, which are ... .
* ... K12, higher education, Further Education, and Corporation.
RECODE
  InstituteClass
  ('Weiterbildung' = 'Further Education')
  ('Continuing Education' = 'Further Education')
  ('Educacin hasta 18 aos' = 'Further Education')
  ('Educacin superior' = 'Further Education')
  ('Formacin continua' = 'Further Education')
  ('Professional Association' = 'Further Education')
  ('Professional Education' = 'Further Education') .
EXECUTE .

* The Dutch universities are made anonymous and recoded into Bb285 to Bb293.
```

The appropriate syntax is assigned to a script number within the text, which corresponds to the script number in Appendix K. This allows us to discern the appropriate calling scripts for the different sections. In Appendix K comments are placed within the scripts to describe the actions taken and to explain the approach. Finally, some datasets carried non-English names, to clarify we have renamed their InstituteClasses to remain with the four classes K-12, further education, higher education and corporate. The descriptive results for the several indicators on the system's uses are presented in the next sections.

5.1.1 Indicator Total Number of Communties and Courses

The total number of Communities and Courses was derived from the CourseMain table. The CourseMain table held the several features for Courses. To obtain an overview of the distribution of the data, we looked at the data on the InstituteClass level and the ServiceClass level. We will present two series of data for the higher education (HE) InstituteClass, these are the two ServiceClasses Communities (C) and Course (F).

We used the `DTCREATED` field from the CourseMain table to determine the total number of Communities and Courses. The `DTCREATED` field was declared only once for initiation of every new Community or Course and considered a unique identifier for counting.

We chose to use a box plot diagram to present the results because it allows us to present the range of samples with minimum and maximum values and quartiles. However, SPSS can only present such plots based on quantitative figures and not on the nominal figures that we had available in the CourseMain table. Consequently, we created an in-between step and built a SPSS custom table with totals, then exported the table to Excel, modified the Excel table for correct loading, and weighed the totals for further calculation. The SPSS syntax is presented for obtaining the data for this indicator in Script 8, see Appendix K.

5.1.1.1 *Results for Total Number of Communities C*

The scatterplot for the higher education datasets is presented in Figure 30. We used the scatterplot to check the datasets for outliers.The left graph of the figure shows that one dataset is out of range, dataset Bb291 had such high figures that it influenced the descriptives in Table 16. The data is presented without the dataset Bb291 in the right graph of Figure 30, it has a much better distribution now.

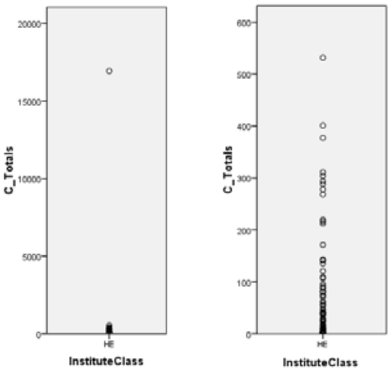


Figure 30: Scatter Plot to discern Outliers before Descriptives are calculated. Left before and right after filtering.

The descriptives for the Communities are listed in Table 16. The higher education (HE) InstituteCass hold 95 institutes or owners that operated 6,642 communities when filtered. The mean number per owner was 223 Communities, however, the minimum was 1 and the maximum number was 532 for one owner. The standard deviation also shows this spread. We calculated the descriptives with and without the outlier dataset. The total of Owners was 96 and the total of Communities was 23,750.

Table 16: Descriptives for Total Number of Communities taken from CourseMain Table

Institute Class	N Owners	N Comm's	Mean	Standard Deviation	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
HE	95	6,642	223.62	146.482	88.00	216.00	304.00	1	532
HE (all)	96	23,750	12,220.72	7517.461	401.00	16928.00	16928.00	1	16928

The box plot for the higher education InstituteClass with the total of Communities per VLE or owner is presented in Figure 31. The minimum and maximum values of the datasets are presented with their whiskers at bottom and top. The lower bound of the box represents the 1st quartile (25 %) and the upper bound the 3rd quartile (75 %). The bold line in the box represents the median or the 2nd quartile (50 %). The outlier Bb291 was removed for this graph.

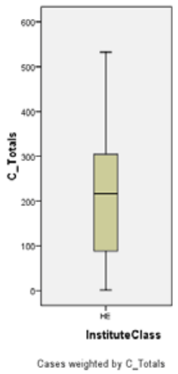


Figure 31: Box Plot for Total Number of Communities (without Bb191) taken from CourseMain

5.1.1.2 *Results for Total Number of Courses F*

The descriptives for the Courses of the higher education InstituteClass are listed in Table 17. This time the mean and median deviate showing a non-symmetric distribution. The scatter plot from Figure 32 indicates that many more datasets were a not normally distributed. Therefore, we did not filter for this exploration and used the original figures.

Table 17: Descriptives for Total Number of Courses taken from CourseMain Table

Institute Class	*N Owner*	*N Course*	*Mean*	*Standard Deviation*	*Percentile 25 %*	*Median 50 %*	*Percentile 75 %*	*Min*	*Max*
HE	*226*	*1,137,139*	*32,271.42*	*31,384.853*	*7,878.00*	*22,073.00*	*49,380.00*	*1*	*107,530*

For the Courses 226 owners held more than one million Courses varying from 1 to the staggering number of 107,530 courses for just one owner. The difference between the mean and median shows us a non-normal distribution.

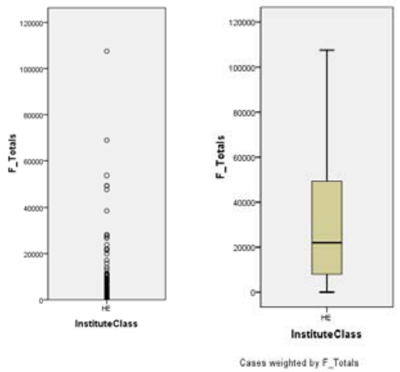


Figure 32: Scatter and Box Plots for Total Number of Courses taken from the CourseMain Table.

The scatter and box plots for the higher education InstituteClass with respect to the total of Courses per VLE or owner are presented in Figure 32. No outliers were removed.

5.1.1.3 *Conclusion for Total Number of Communities and Courses*

We took the CourseMain table as our data source to present the total numbers for Communities and Courses. CourseMain held the original figures presented in accumulated figures within the System Tracking table, from which management reports usually are generated. The figures of the Communities and Courses tell us that the data distributions are diversed and that they hold institutes with significantly smaller and larger data samples.

The data of the communities and courses were quite diversed.

The totals for the number of Owners, of Communities and of Courses including their ratios are listed in Table 18. It appears that about 41 percent of the higher education institutes rolled out Communities and about 96 percent rolled out Courses. The Communities and Courses Totals are shown in the right half of the table. The small 2 percent for the Communities is striking when compared to the totals. However, this may be explained by the fact that it has only been possible to create Communities since Blackboard version 6.0 and further. We collected data for the year 1999 onwards and it was sometime in 2003 when the Communities functionality came into play.

Communities were rolled out by 41 percent of the higher education institutes.

Courses were rolled out by 96 percent of the higher education institutes.

Table 18: Descriptives for Total Number of Communities and Courses taken from CourseMain Table

Institute Class	Owner Total	Owner C	Owner C %	Owner F	Owner F %	Total C + F	Comm's Total	Comm %	Courses Total	Course %
HE	236	96	40.7%	226	95.8%	1,160,889	23,750	2.0%	1,137,139	98.0%

As presented in Chapter 4 we were interested in Communities and Courses, which only hold user activities related to educational applications of the Blackboard VLE. In the next section we will explore such figures.

5.1.2 Indicator Virtual Community and Online learning Course

In order to discern the Communities and Courses from the CourseMain table from those from the Handle table we introduced the Virtual Community (VC) and Online learning Course (OLC). The VCs and OLCs are the Communities and Courses where educational applications from the Blackboard VLE are initiated. In the Handle table only the Communities and Courses were registered that carried 'application calls' or 'seat time activities' from users, seat time activities for starting educational functionalities of the Blackboard VLE, see Section 4.4.3. When more seat time activities were executed within the same Course they were also recorded but in separate fields. In order to determine the correct number of VCs and OLCs we identified such duplicates and filtered on unique Course IDs. In such way, it allowed us to obtain correct totals for our data. SPSS syntax to obtain the data is presented in Script 9, see Appendix K.

5.1.2.1 Results for Total Number of Virtual Communities VC

The descriptives for the collected VC samples is listed in Table 19. As we can see in the scatter plots of Figure 33 the dataset Bb291 deviates from the other datasets, thus, we removed it from the box plot.

Table 19: Descriptives for Total Number of VCs taken from Handle Table

Institute Class	N Owners	N VCs	Mean	Standard Deviation	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
HE	52	2,523	180.6	115.323	70.00	167.00	302.00	1	356
HE (all)	53	7,676	3,518.64	2,336.801	302.00	5,153.00	5,153.00	1	5,153

As we can see the number of owners with VCs is very low when compared to Table 16 where the Communities are listed, 7,676 VCs remained that could be used to confront the 2nd hypothesis. When the mean and median values are compared we notice that the values deviate. This means that the distribution of the sample is not normally distributed.

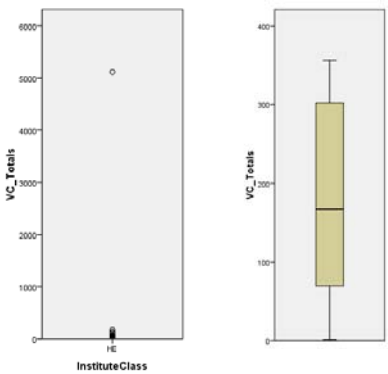


Figure 33: Scatter and Box Plots for Total Number of VCs taken from Handle Table

The scatter plot without filtering and the box plot with filtering for the higher education InstituteClass concerning the VCs is presented in Figure 33. The figures from Table 19 are presented in the graphs.

5.1.2.2 Results for Total Number of Online Learning Courses OLC

The descriptives for the collected OLCs samples are listed in Table 20. There are 166 owners holding 112,071 OLCs with seat time activities.

Table 20: Descriptives for Total Number of OLCs taken from Handle Table

Institute Class	N Owners	N OLCs	Mean	Standard Deviation	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
HE	166	112,071	1,915.81	1,461.514	797.00	1,442.00	2859.00	1	5,460

When the mean with median values are compared we can see that the figures deviate. This means that the distribution of the samples for the OLCs is not symmetric, this is also indicated by the scatter plot in the left graph of Figure 34.

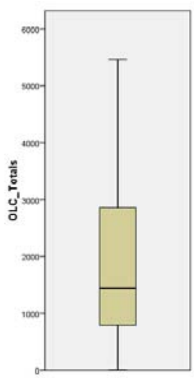


Figure 34: Box Plot for Total Number of OLCs taken from the Handle Table

5.1.2.3 Conclusion for VC and OLC

Virtual communities were rolled out by 30 percent of the higher education institutes.

We took the Handle table as our source to present the total numbers of VCs and OLCs. The Handle table held the logged seat time activities as present in the *BB_BB60_STATS.ACTIVITY_ACCUMULATOR*. However, such logging was only started with Blackboard versions 6.0 and higher. In addition to Section 5.1.1.3 the ratio between the VCs and OLCs should be more appropriate because this takes into account overlapping time periods only. No courses were registered in the Handle table without seat time activities during this overlapping period.

Online courses were rolled out by 97 percent of the higher education institutes.

The totals for the number of Owners from the Handle table, the number of VCs and the number of OLCs including their ratios are presented in Table 21. It appears that about 30 percent of the institutes rolled out VCs and about 97 percent rolled out OLCs. What is striking is still the small percentage, 2.2 percent for VCs, when compared to the totals.

Table 21: Descriptives for Total Number of VCs and OLCs from Handle Table

Institute Class	Owner Total	Owner VCs	Owner VC %	Owner OLCs	Owner OLC %	Total VC+OLC	VCs Total	VC %	OLCs Total	OLC %
HE	171	52	30.4%	166	97.1%	114,594	2,523	2.2%	112,071	97.8%
HE (all)	171	53	30.8%	166	96.5%	119,747	7,676	6.4%	112,071	93.6%

5.1.3 Indicator Ratio for VC and OLC

As presented in Section 4.3.3 we also calculated the ratios for Communities with VCs, and for Courses with OLCs. We took the same approach as the former sections to obtain the ratios between VCs and Communities and between OLCs and Courses. The way of work was already explained in Script 9, see Section 5.1.2.

5.1.3.1 Results for Ratio VC

The descriptives for the VC ratios are listed in Table 22. We calculated the ratios based on the distribution of the Communities and VC datasets. This allowed us also to determine the standard deviation. The figures are given in percentages.

Table 22: Descriptives for Ratio of VCs versus Communities

Institute Class	N Owners	Mean	Standard Deviation	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
HE	52	73.4%	26.1%	53.9%	79.4%	100.00%	1.75%	100%
HE (all)	53	73.1%	25.8%	55.5%	79.1%	100.00%	1.75%	100%

One may say that the ratio is about 79 percent as the data concentrate around the median value. This means that about 79 percent of the initiated virtual communities were actively used and remained in operation by their users. About 21 percent had no activities used and were probably try-outs or automatically generated Communities.

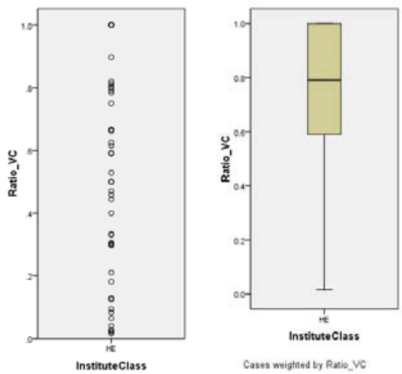


Figure 35: Scatter and Box Plots for the Ratio of VCs versus Communities

The box plots for the higher education InstituteClass are presented in Figure 35. The figures of Table 22 are presented graphically in this figure.

5.1.3.2 Results for Ratio OLC

The descriptives for the OLC ratios as percentages are listed in Table 23. The figures seem to be normally distributed if we consider the mean and median values.

Table 23: Descriptives for Ratio of OLCs versus Courses

Institute Class	N Owners	Mean	Standard Deviation	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
HE	166	47.3%	26.47%	28.4%	43.7%	67.7%	1%	100%

The scatter plot and box plot for the Ratio OLC are presented in Figure 36. The figures indicate that nearly 44 percent of the initial courses were placed online and remained in operation. About 56 percent of them had no activities logged, however, we must keep in mind that no educational activities were logged in the early years of the Blackboard VLE. The logged figures for the diverse totals from the early years were mixed up with those of higher versions when upgrades of the system took place.

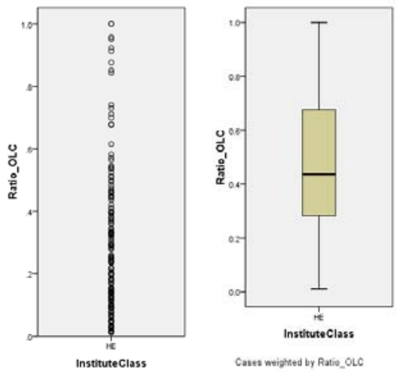


Figure 36: Scatter and Box Plots for the Ratios of OLCs versus Courses

5.1.3.3 Conclusion for Ratios VC and OLC

Seat time activities were present in 80 percent of the communities.

Considering the figures as collected, 80 percent of the Communities, contained seat time activities. Only 44 percent of the Courses, contained seat time activities. Holding seat time activities means that students, faculty and staff use the Communities and Courses for their educational practice. In such way, we speak of respectively VCs and OLCs. Seat time activities have been logged from Blackboard version 6.0 and higher, and Courses had been logged from about three years earlier using system versions lower than Blackboard 6.0. We know that educational activities could only be logged from somewhere in 2003 onwards. Hence, many Courses lacked the logged activities.

Seat time activities were present in 44 percent of the courses.

It also depends on the institute, when a VLE was first started, hence, it was very hard to draw concise conclusions. When upgrades of the VLE took place from lower to higher versions then the earlier logs with total numbers of Courses were transposed into the log file tables of the higher version using variables carrying the same name. Communities became available somewhere in the year 2003. In the Blackboard VLE, Communities have a very similar layout and presentation to Courses. In fact, they have the same functionalities but are assigned a different system flag. The distinction that we used between Communities and Courses was therefore rather thin, however, the aim of the educational application was quite different. That the Communities and Courses were quite similar opened the possibility for the user to apply Courses as Communities. With upgrades up to higher versions of Blackboard the older log files were only transposed into the log files of Courses. This means that the mixed figures from earlier versions were all treated as Courses in the log files of the higher version. This led to skewed statistics, because Courses had been in place for about 7 years and Communities for 3 years. This left us with figures from which it was not possible to find exact dates when the log files became mixed. In contrast we had the shares from the Communities and the VCs for higher education at only 2.0 percent respectively 2.2 percent. This difference when compared to the figures from Table 16 and Table 19 is small enough to consider the figures reliable.

Communities and virtual communities represent only 2 percent and 2.2 percent of the total number of courses respectively total number of active courses.

5.1.4 Indicator Lifespan Period or CourseLength

The lifespan periods of Communities and Courses, and of VCs and OLCs denote lengths in time of existence or CourseLength. We derived the CourseLength in two ways. One, we described the results for the Communities and Courses taken from the CourseMain table. Two, we described the results for the VCs and OLCs taken from the Handle table.

5.1.4.1 Lifespan Period or CourseLength from CourseMain

We determined the CourseLength by taking the Communities and Courses from the CourseMain table where the `DTCREATED` represented the unique date of origin for as course. In the CourseMain table also the `DTMODIFIED` was recorded, this contains the date when the last modification was done to a Course. Such modifications are a logged system handle or a logged user handle. We only had to subtract the creation date from the last modification date to obtain the lifespan period from CourseMain. The syntax showing how this was done is given in Script 11, see Appendix K. The descriptives for the Communities and Courses are presented in Table 24.

Table 24: Descriptives for CourseLengths in Months of Communities and Courses from CourseMain Table

Course type	N	Mean	Std.Dev.	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
Comm's	23,750	4.98	7.14	0	2	9	0	58
Comm's <> 0	13,174	8.90	7.50	4	8	11	1	58
Courses	1,137,139	7.03	11.18	0	2	9	9	84
Courses <> 0	635,088	12.58	12.40	4	8	17	1	84

We made a distinction for the number of Communities with and without CourseLengths of value zero to calculate the mean and standard deviation. There were large numbers of Communities and Courses with a lifespan period of zero months or CourseLengths shorter than 15 days. We have already mentioned the non-Communities and non-Courses in Section 4.3.2. We assumed that system administrators generated such Communities and Courses automatically. Our interviews with users corroborated this assumption.

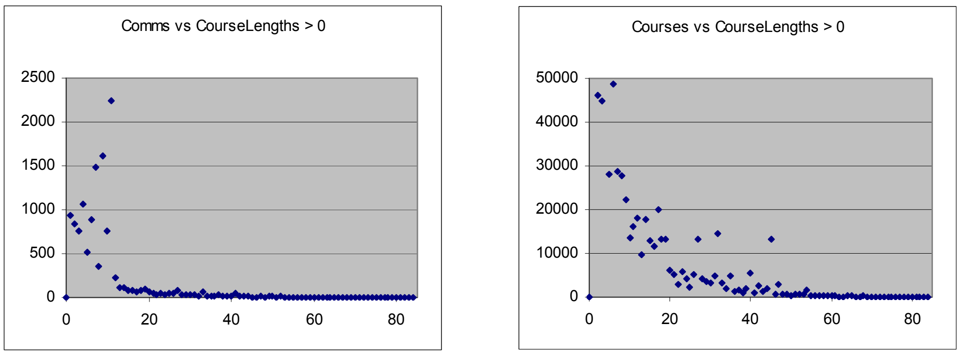


Figure 37: CourseLengths in Months for Communities and Courses from CourseMain without Zero Values

The CourseLengths of the Communities and Courses are presented graphically in Figure 37. In the left graph the Communities are pictured, in the right the Courses, both without the zero values. The values are not normally distributed considering the mean and median values, the standard deviation and the graph.

5.1.4.2 Lifespan Period or CourseLength from Handle

The second way to determine the CourseLength but only for VCs and OLCs, is to use the Handle table where the educational activities of the users are logged. Looking at the activities of VCs and OLCs, it can be taken as fact that those were active. However, the user activities have only been logged since the VLE version 6.0

or higher, which means that we only could determine CourseLengths for VCs and OLCs that were created after the handle logging began somewhere in 2003. The syntax is given for how this was done in Script 12, see Appendix K.

The descriptives for VCs and OLCs are presented in Table 25. In order to obtain the CourseLengths from the Handle table we scanned all 123 million samples. We then selected the unique Course IDs and disregarded duplicates. Next, we aimed only at higher education VCs and OLCs. A distinction is made for VCs with and without Courselengths for the zero values. We did the same exercise for the OLCs.

Table 25: Descriptives for Courselengths in Months of VCs and OLCs from Handle Table

Course type	N	Mean	Std.Dev.	Percentile 25 %	Median 50 %	Percentile 75 %	Min	Max
VCs	7,676	4.37	5.48	0	2	7	0	30
VCs <> 0	5,313	6.32	5.57	2	4	10	1	30
OLCs	112,071	3.52	4.40	0	3	5	0	35
OLCs <> 0	79,571	4.96	4.48	2	3	5	1	35

The VCs and OLCs are presented graphically in Figure 38. The left graph presents the VCs and the right graph the OLCs, both without the zero values of the Courselength.

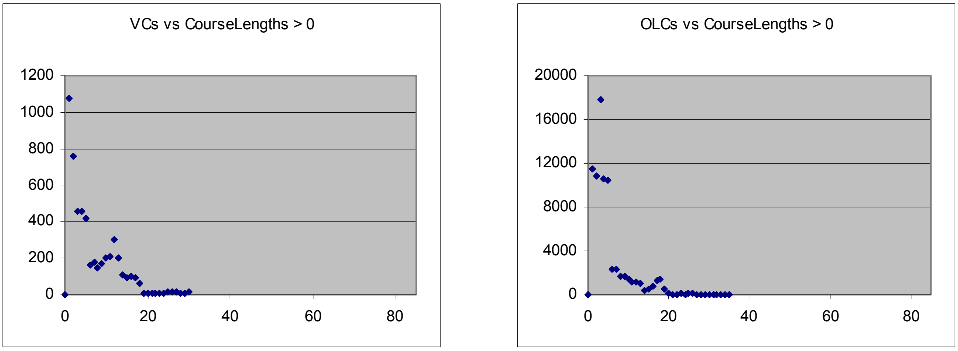


Figure 38: Number of CourseLengths for VCs in Months from Handle. The Right Graph is without Zero Values

5.1.4.3 *Conclusions for Lifespan Period*

About 44 percent of the communities and courses had CourseLengths values of zero, these were automatically generated.

It is striking that so many CourseLengths were present with a zero value or better put with a lifespan period shorter than 15 days. For both Communities and Courses the zero values account for around 44 percent. The remaining 13,174 Communities and 635,088 Courses were used to test the 1st hypotheses. For both the VCs and OLCs the zero values account for around 30 percent. The remaining 5,313 VCs and 79,571 OLCs were used to test the 2nd hypothesis. Due to the large numbers of the non-courses we are confident in saying that they were automatically generated. Informal interviews with system administrators corroborated with this assumption, see Section 4.5.1. It is obvious that the values are not normally distributed when one look at mean and median values and graphs. If we wanted to use the CourseLength values to test hypothesis 1 then we had to normalise the starting dates and their lifespan periods. Consequently, we transposed the calendar times of all the VLE Courses into Lifespan Months on a Lifespan Axis, see Section 5.2.

About 30 percent of the VCs and OLCs had CourseLengths values of zero, these were automatically generated.

5.1.5 Indicator Number of Users for VC and OLC

We counted the number of users who executed actions. Using the *USER_ID* we counted the unique and duplicate records for all types of users from the Handle table, this allowed us to determine the unique number of users and the number of actions per type of user.

We discerned multiple types of users for the VCs and OLCs of the collected datasets. However, as mentioned before, we only looked at the roles of student, faculty and staff. The syntax used to obtain the figures for the users is presented in Script 10, see Appendix K.

5.1.5.1 Results for Users of VC

The descriptives for the users of VCs is listed in Table 26. The data was taken from the Handle table with its 123 million records. First, we determined the unique users, and even though our main interest focussed on student, faculty and staff, we still wanted to know what parts of the total numbers could be attributed to each group. Hence, we combined the other user types under the term 'others'. This allowed us to calculate the users percentages as presented in Table 26 and Figure 39.

Table 26: Descriptives for VC Users taken from Handle Table

User Class	*Unique Users*	*Users Percentages*	*Action Totals*	*Action Totals Percentages*	*Mean of User Actions*	*Std.Dev. User Actions*	*User Percentages*
student	*3,461*	*46.4%*	*1,490,890*	*41.3%*	*431*	*471*	*26.1%*
faculty	*711*	*9.5%*	*244,485*	*6.8%*	*344*	*265*	*20.1%*
staff	*685*	*9.2%*	*182,090*	*5.0%*	*266*	*246*	*15.6%*
others	*2597*	*34.8%*	*1,694,979*	*46.9%*	*653*	*614*	*38.2%*
Totals	***7,454***	***100.0%***	***3,612,444***	***100.0%***	***427***	***399***	***100.0%***

About 46 percent of the users were students and about 19 percent were Instructors while 35 percent were other types of users. The ratio of Instructors to students is about 1 to 2.

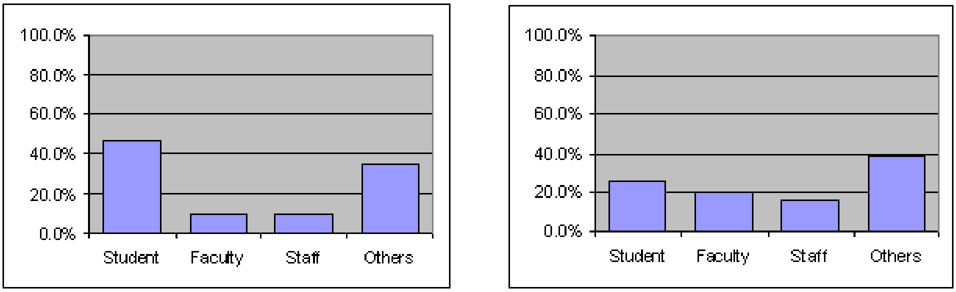


Figure 39: Left the Number of Unique VC Users and Right the Mean of User Actions

We counted the total of actions for the users and calculated the mean number for the users student, faculty, staff and others. According to the figures and graphs the students took almost half the share as participants in the VCs, while faculty and staff had approximately ten percent share each. If we look at the shares of the different users from the Action Totals then instructors, as the combination of faculty (6.8 %) and staff (5.0 %), had an 11.8 percent share. However, when we consider the mean of user actions per type of user their percentages give another image: the students took a 26.1 percent part and the instructors, as faculty and staff taken together, took an even greater part with a 35.7 percent share. This delivers a ratio of 1.37, which means that for every student an instructor executes a 1.37 times higher number of actions within the VCs.

5.1.5.2 *Results for Users of OLC*

The descriptives for the users of the OLCs are presented in Table 27. When we study the figures and look at the graphs from Figure 40 then the students represent an incredible 83.3 percent of the share. The instructors, as faculty and staff combined, represent 6.9 percent, which gives a ratio of 1 to 12.

Table 27: Descriptives for OLC Users taken from Handle Table

User Class	Unique Users	Users Percentage	Action Totals	Action Totals Percentages	Mean of User Actions	Std.Dev. User Actions	User Actions Percentages
student	113,778	83.3%	85,164,926	76.4%	748	310	19.0%
faculty	4,333	3.2%	7,581,964	6.8%	1,750	1,146	44.5%
staff	5,085	3.7%	3,982,607	3.6%	783	714	19.9%
Others	13,324	9.8%	14,796,497	13.2%	651	651	16.6%
Totals	**136,520**	**100.0%**	**111,525,994**	**100.0%**	**3,932**	**637**	**100.0%**

If we take the 'mean of user actions' per type of user then faculty has a very high score. And if we combine the Means of faculty and staff as instructor then some amazing ratio is coming up for the executed actions. A ratio of 3.34 for the instructor against the student means that an instructor does have more than thrice the number of actions to execute when Courses are online with the Blackboard VLE.

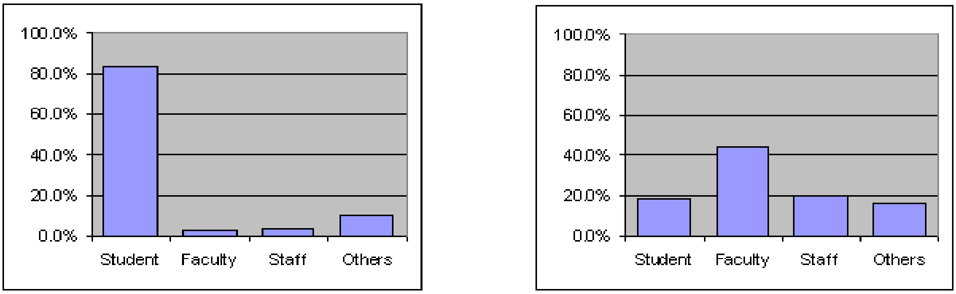


Figure 40: Left the Number of Unique OLC Users and Right the Mean of User Actions

5.1.5.3 *Conclusion for Number of Users for VC and OLC*

We derived the number of unique users from the Handle table for both the VCs and the OLCs. The VCs' users executed about 3.6 million actions and the OLCs' users did a staggering 111.5 million actions. This delivers a ratio of about 1 to 31.

> Instructors must fulfill many actions per student to keep the discussions going in the communities.

It appeared that the VCs were used by many different users. The share of the other users excluding students, faculty or staff was almost 35 percent. The shares of the student actions versus the instructor actions had a ratio of 1 to 1.37. If we are reasoning in an abductive way, following the path from effect to cause, based on the premise that a VC is set up for sharing and communicating, than we might assume that students and instructor have more or less a one-to-one communication pattern. However, the figures show a ratio of about 1 to 2. This gave us the idea that instructors must fulfil about 0.69 times the number of actions per student to keep the discussions going. If that is the case and we look at the efficiency and ease of use results from our qualitative explorative case than we must ask ourselves if the VLE system is the right equipment to use to execute online communication. The VLE may simply demand too many resources from the instructors.

The OLCs presented us with a quite different pattern of usage. The other category took a less than 10 percent share. It is more obvious that efficiency, as the DUT case taught us, plays a role because of the tremendous number of students compared to the number of instructors. There were about 12 times more students in the OLCs than instructors. However, the figures for mean of user actions gave a ratio of 1 to 3.34. This means that instructors used about 0.28 actions per student to keep the Courses going. This is still a large number of actions, but if we are reasoning in an abductive way then we may assume that instructors will execute many short term actions and the students will carry out long term actions. Such can be the case when instructors place learning materials and announcements online, as the DUT case taught us, and students go online to study this subject matter. If we consider our qualitative explorative case then this seems to be a reasonable explanation. Thus, instructors need to carry out many activities to put the subject matter online, but after that the effort is definitely paid back. We will explore this further in the descriptive section 5.3 on educational uses of the Blackboard VLE.

> *Instructors need to carry out many activities to put subject matter online, but after that the effort is definitely paid back.*

5.2 TEST ANALYSIS FOR SYSTEMS' USES

Now that we have described the different indicators for the system's uses it is time to reflect on the implementation strategies, which we discussed as part of a main literature stream in section 1.3.3. We have designed the big picture, which is educational technology placed on a calendar timeline, and the small picture, which is the empirical data to confront with the theories outlined in Chapter 2. We wondered if there was a connection between the evolution of the universities, where the big picture was synthesised, and the uses of the VLE, where the discrete logging data is most important.

In the following section, our empirical data is transposed to a normalised form to compare it with the theoretical framework. Firstly, we transposed the calendar times of the collected data to the Lifespan Axis. Secondly, we normalised the Y-Axis so we could use a nonlinear regression method, which formed the third step.

5.2.1 Normalising the X-Axis from Calendar Time to Lifespan

We have used the Communities and Courses totals from the higher education InstituteClass and expressed them in monthly figures to confront the theories from Chapter 2 with the empirical data for hypothesis 1. We also used the monthly notation for the Lifespan Axis on which we have put the growth figures, and we took Nolan's theory, discussed in Section 2.4.2, to explore the growth of VLEs.

We normalised the data by transposing the calendar time of all the Courses onto the Lifespan Axis. Figure 41 helps us to explain how we carried out the normalisation process. We took the Course with the very earliest `DTCREATED` out of our collected datasets, which was January 1999. That date was positioned as first month on the Lifespan Axis. Every VLE Owner had their own VLE system start month, which was converted to the first Lifespan month on the Lifespan Axis despite its calendar time. Then looking at the points on the Lifespan Axis the Courses' timestamps were counted for the Lifespan Month that corresponded to a particular VLE system start month added to its course delays.

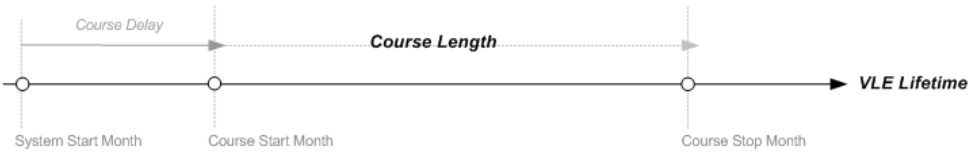


Figure 41: Schematic Overview of Composition for CourseLength and VLE Lifespan

Once we had transposed all the datasets on the Lifespan Axis we worked out several directions to discover coherence within the data points as a whole. At first, we simply counted the number of Courses per Lifespan month and divided them by the total number of owners, which delivered proportionally divided Courses for each month. This was used to obtain the ratio of Courses, or the Owner Ratio. We did the same with the UserClasses, both the Owner Ratios and the UserClasses were not normally distributed. When we looked at SPSS checking methods skewness and kurtosis to check for normal distribution the results were not good enough, and when we tested for a normal distribution using Kolmogorov-Smirnov the results were negative (higher than 0,05).

We set out the ServiceClasses C and F on the Lifespan Axis. An overview of the data points for Communities and Courses is shown in Figure 42. The cloud of data points are randomly distributed. The circular data points are Courses with a scale on the left Y-axis and the triangular data points are the Communities with a scale on the right Y-axis. The tremendous increase in Communities between month 36 up to month 55 is striking. These months correspond with a term of about 1.5 years starting at calendar time January 2002 up to June 2003. It seems plausible that the updates of the VLEs to version 6.0 took place during that period.

Despite further study no viable answers were obtained. It must be the Communities and Courses that carry the answers, thus we next analysed the CourseClasses.

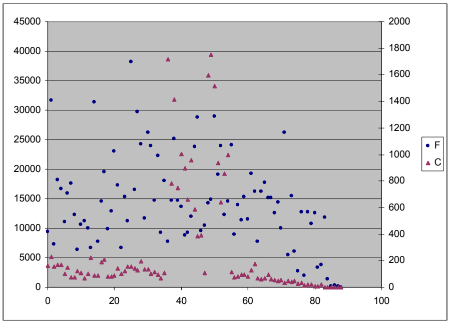


Figure 42: ServiceClasses F and C on Lifespan Axis

One of the premises used when working with statistical methods is to assume that the data must be normally distributed. When this is not the case then one is not allowed to use usual instruments. Thus because our data was not normally distributed, we had to introduce curve fitting strategies.

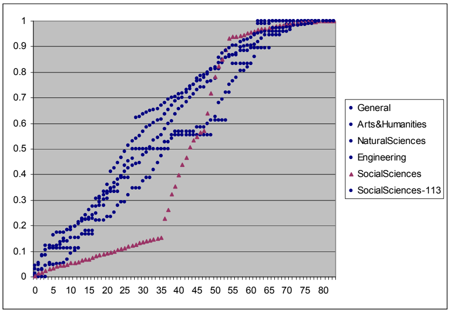
5.2.2 Normalising the Y-Axis for Communities and Courses

In Figure 29, Chapter 4, we presented our Classification Schema which was used to order and structure all the data from our collected datasets. The schema consisted of 5 ScienceClasses, 236 CourseClasses, 4 InstituteClasses and 3 ServiceClasses drawn from 289 Owners. Taking the InstituteClass we only used higher education and from the ServiceClasses we used the Communities and Courses, which both carry CourseClasses and can be categorised into ScienceClasses. In our way of work we studied the CourseClasses for the Communities and Courses separately. The results for each of the two series were summed and categorised into the five ScienceClasses.

We set out the 238 CourseClasses over the Lifespan Axis and counted the totals for the 2 ServiceClasses Communities and Courses in separate views. We did the same procedure for all 4 InstituteClasses but we will only present the results for higher education. The next step was to combine the CourseClass averages for every one of the 5 ScienceClasses. The Social Sciences needed some special attention, as mentioned earlier we found that increasing numbers of Courses were generated automatically by the system administrators. This produced many Courses with the default CourseClass named higher_education. That higher_education CourseClass with ID_113 is not the same as the InstituteClass higher education. Hence, we processed the Social Sciences using ID_113 separately in parellel to the five assigned ScienceClasses, which means that we have continued to work with 6 ScienceClasses.

The 6 distinguished ScienceClasses were set out cumulatively to follow the growth over the Lifespan months. We took the maximum values of the last Lifespan month and assumed these the virtual maximum growth figures. Although we knew that these were not the true maximum values we could normalise the Y-axis by dividing the monthly figures with their maxima. The sample data points for Communities and Courses are presented for the 6 ScienceClasses in Figure 43.

In the left graph of Figure 43 the ScienceClass totals of the Communities' original values vary between averages of 3 up to 23 Communities per month. The ID_113 had an average of 428 Communities per month, which shows a deviated growth pattern. The ScienceClass totals of the Courses are presented in the right graph. Their values vary between averages of 175 up to 500 Courses per month and although the ID_113 had an average of more than 10,000 there is little deviation visable. The results of the transposed figures were loaded into SPSS to search for a model that would fit the patterns presented in Figure 43.



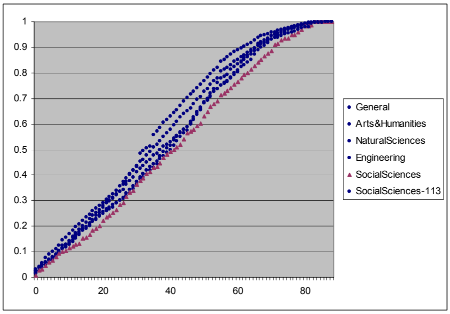


Figure 43: ScienceClass Totals for Communities and Courses normalised by their Maximum Values

The Growth for the 6 ScienceClasses for both Communities and Courses are shown in Figure 43. Note: The Social Sciences were given a different signature for recognition.

5.2.3 Nonlinear Regression as Curve Fitter

We used the Gompertz curve as presented within our theoretical framework, see Section 2.2, to look for growth patterns and similarities. The Gompertz curve holds 3 independent variables, which are 'a' for vertical movement or maximum value, 'b' for horizontal movement and 'c' for slope angle. The dependent variable is Lifespan month. The Gompertz curve also holds exponential components based on the natural logarithm 'e' with value Exp = 2.71828. The outcome of the formula represents growth. For our study the outcome indicated the 'Implementation Grade' because our original goal was to estimate the order of growth for the Blackboard VLE system's uses within the higher education institutes. In other words, we determined the extent of growth for the Communities and Courses compared to their maximum values within the institutes. The Implementation Grade is expressed in percentages from 1 to 100 percent.

The Gompertz curve formula represents the Implementation Grade (IG), which is
IG = a * Exp(-b * Exp(-c * LifespanMonth)).
a = vertical shifter or upper asymptote
b = horizontal shifter, which has negative value
c = growth rate, which has negative value
Exp = 2.71828, which is natural logarithm e
The growth rate is slowly increasing at the start and slowly decreasing at the end.

The variable 'a' is the maximum growth figure and must indicate the maximum number of Communities or Courses for the Owners. However, as mentioned we did not know, and could not find out, the maximum values for the 289 institutes. Therefore, we chose to take the cumulated maxima of the CourseClasses as theoretical maxima and normalised these data to a maximum value of 100 percent.

In order to get a feel for the independent variables of the Gompertz curve an impression of a Gompertz curve is given in Figure 44 with different values for the independent variables. In the left graph the independent variable 'a' varies from 0.5 to 1 to 2, while 'b' and 'c' are kept at a constant value of 1. It is obvious that 'a' represents the vertical asymptote. The middle graph presents 'b' with the values 0.5 to 1 to 2 while the others values are kept constant. The changing constant 'b' causes a horizontal shift. Finally, in the right graph the independent variable 'c' is varied while 'a' and 'b' are kept constant. In the right graph it is the slope of line that changes while 'c' is assigned a value of 0.5 to 1 to 2. This slope stands for the 'rate of change'.

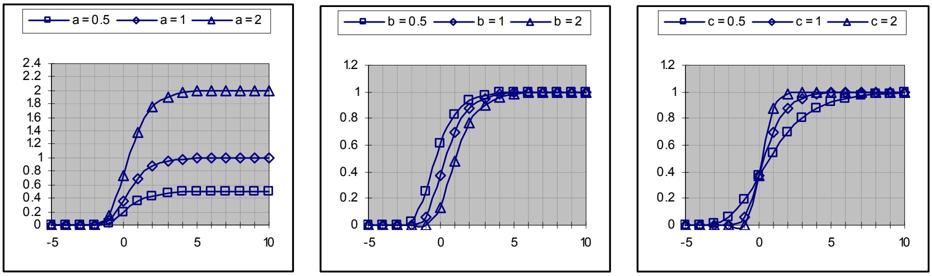


Figure 44: Gompertz Curve with its independent Variables and their Influence

We used a nonlinear regression method to find a model that fits the Gompertz curve as represented in Figure 44. Nonlinear regression is a method that is used to find a nonlinear model that consists of a set of independent variables and a dependent variable. Linear regression is used to estimate linear models, while nonlinear regression can be used for the Gompertz curve. SPSS supports nonlinear regression with a modelling instrument where the independent variables can be user-generated. Using an iterative estimation algorithm we used SPSS to approach the Gompertz curve and to determine the independent variables for both Communities and Courses, see Script 13 in Appendix K.

During the estimation process SPSS was used to test the residual sum of squares so that the next estimation could be done. The model stops if the number of estimates grow too quickly or when the residuals no longer change, in other words when an optimum is achieved.

Table 28: The Estimates of Curve fitting for System's Uses of Communities

ScienceClass	a	b	c	R-squared	Lifespan
General Sciences	1.310	3.041	0.032	0.960	277
Arts & Humanities	1.336	3.236	0.032	0.991	277
Natural Sciences	1.029	3.901	0.061	0.991	145
Engineering	1.139	2.793	0.040	0.996	222
Social Sciences	1.039	61.252	0.105	0.983	50
Social Sciences minus ID_113	1.068	2.861	0.049	0.997	181
Averaged after normalised	**1.000**	**3.166**	**0.043**	**0.987**	**207**

Using Script 13, see Appendix K, the nonlinear regression model for our 6 ScienceClasses were activated to determine what values the independent variables required to follow our empirical data. The results for the Communities are listed in Table 28. The nonlinear model generated 'a' values that were larger than 1.0. However, we normalised these deviated 'a' figures once more to draw the curves in one diagram, as shown in Figure 44. If we consider the independent variables of Table 28 it is obvious that the 'b' and 'c' of Social Sciences are very different compared to the rest of the ScienceClasses. However, all R-squared values are very high, which means good estimates for the curves and reliable predictors based on the empirical data.

The R-squared is a statistical term, most often used in linear regression, it is used to determine how well a formula will predict another curve based on the same premises. Given a set of data points, linear regression gives a formula for the line most closely matching points, and the R-Squared test shows how well the resulting line matches the original data points. If the R-squared value is 1.0 then the given formula will perfectly predict another term of that curve, but if the R-squared is 0.0, then another term cannot be predicted. More generally put, the higher the value of R-squared the better we can predict one term from another.

The predicted curves, shown in Figure 45, are based on the three independent variables 'a', 'b' and 'c', and on the dependent Lifespan variable. The Lifespan values were added at the lower end and at the higher end until the results varied by less than 0.1 %. This span of months is given in the Lifespan column. The empirical data represent only the part of the generated curves between the first month to the 88th month. Those parts are indicated using red intermittent lines at Lifespan01 and Lifespan88. Between the red lines are the empirical values and to the left and right of the red lines are the calculated values based on the Gompertz curve.

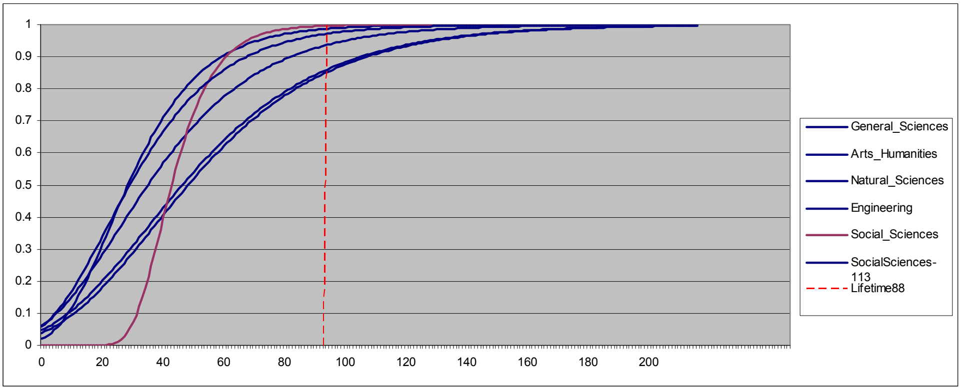


Figure 45: Fitted Curves for ScienceClasses of Communities

An average value was calculated for the ScienceClass based on the General Sciences, Arts & Humanities, Natural Sciences, Engineering and the Social Sciences minus the CourseClass ID_113. These average values are presented in the last row of Table 28. Using these values the averaged growth curve can be calculated using the following formula:

F1: Community Implementation Grade = Max.Communities * Exp(-3.166 * Exp(-0.043 * LifespanMonth))

The estimated lifespan of a virtual learning environment based on the uses of its communities is 17.25 years.

In the formula 'Max.Communities' stands for the maximum number of possible communities within an institute. An R-squared value of 0.987 indicated that this Community Implementation Grade formula should be a very good predictor. We have cut the lifespan months at the lower range and at the higher range when the values became lower than 0.001 and higher than 0.999. This resulted in a Lifespan period of 207 months, which corresponds to 17.25 years. The resulting s-curve is presented in Figure 46.

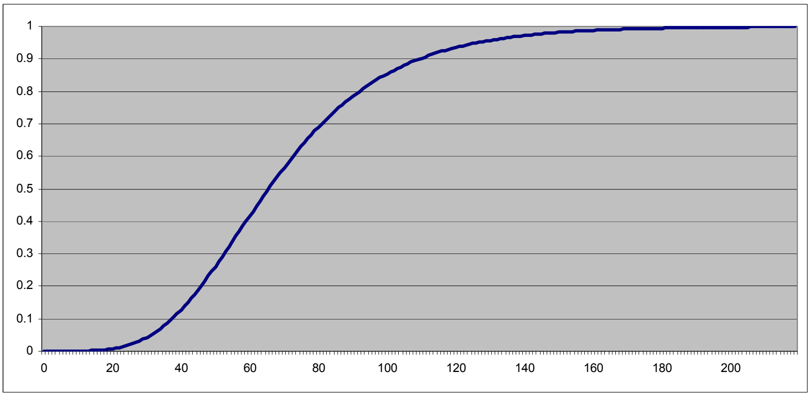


Figure 46: Implementation Grade based on the Gompertz Curve for Communities

The same procedure as described above was followed to obtain the Implementation Grade for the Courses. The results of our nonlinear regression model are given in Table 29.

Table 29: The Estimates of Curve fitting for System's Uses of Courses

ScienceClass	a	b	c	R-squared	Lifespan
General Sciences	1.220	3.064	0.034	0.997	261
Arts & Humanities	1.231	3.228	0.034	0.998	261
NaturalSciences	1.227	3.389	0.035	0.996	254
Engineering	1.089	3.402	0.046	0.998	193
Social Sciences	1.258	3.366	0.320	0.999	29
Social Sciences minus ID-113	1.139	2.916	0.037	0.998	240
Averaged	**1.000**	**3.200**	**0.037**	**0.997**	**238**

The nonlinear model for the Courses generated 'a' values that were also larger than 1.0. We normalised them in order to draw the curves from Figure 47. If we consider the independent variables it is clear that the rate of change indicated by the 'c' of Social Sciences deviates when compared to the rest of the ScienceClasses. The high 'c' generates a very steep slope as can be seen from Figure 47.

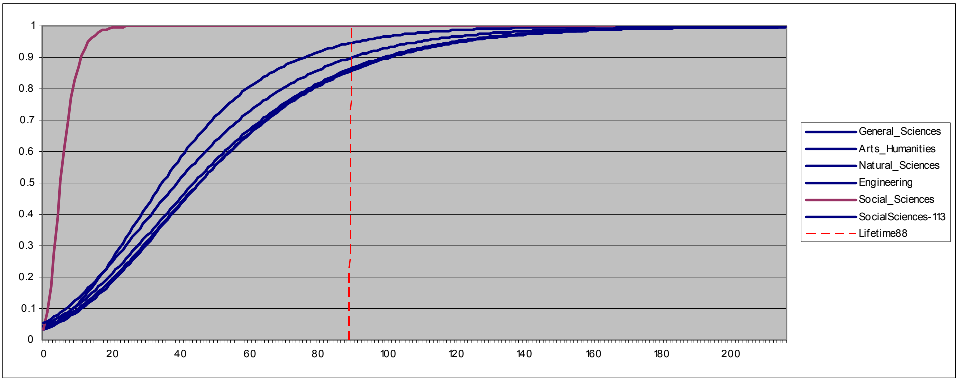


Figure 47: Fitted Curves for ScienceClasses of Courses

All the R-squared values are very high and thus reliable predictors, in Figure 47 our empirical data represent only parts of the generated curves, indicated by the red intermittent lines at Lifespan01 and Lifespan88. The values at the lower end and the higher end were calculated using the Gompertz curve. An average value was calculated based on all of the ScienceClasses minus the Social_Sciences, which is presented in the last row of Table 29. This led us to the following formula for the averaged curve of the Course Implementation Grade:

F2: Course Implementation Grade = Max.Courses * Exp(-3.200 * Exp(-0.037 * LifespanMonth))

The estimated lifespan of a virtual learning environment based on the uses of its courses is 19.83 years.

The complete Course Implementation Grade was calculated with this formula. 'Max.Courses' stand for the maximum number of possible Courses within the institute. The R-squared value of 0.997 indicated that this Gompertz curve is a perfect predictor. We cut the curve lifespan months at the lower range and at the higher range when the values became smaller than 0.001 and higher than 0.999. This resulted in a Lifespan period of 238 months, which corresponds to 19.83 years. The resulting curve is presented in Figure 48.

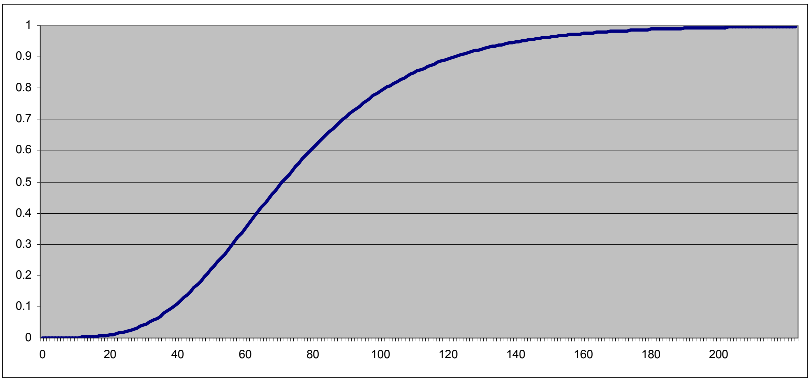


Figure 48: Implementation Grade based on the Gompertz Curve for Courses

5.2.4 Conclusion of System's Uses

According to Yin (Yin, 2002) pattern matching is one of the most desirable strategies within a case study approach. Pattern matching is used to compare an empirically based pattern derived from collected data with a predicted pattern. In our study we used the Gompertz-curve as a theoretical growth pattern to represent our Implementation Grades. We also wondered if innovation theories stemming from the corporate sector could be applied to the educational field. Nolan's S-curve is described in Section 2.4.2, with its initiation, contagion, control and integration phases (Nolan et al., 1992; Nolan & Gibson, 1974) and we used this curve to see if this theory could be applied to education. Our inductive approach (Miles & Huberman, 1994) in search of recurrent phenomena within the collected empirical datasets corroborates with S-curve like growth for the use of VLE systems within higher education.

If we refer to question b "Can the S-shaped curve, as product forecasting approach, be used to catch the growth of educational technology in operation?", posed in Section 2.2, we can answer affirmatively.

In the Delft Case, use of the Blackboard VLE was officially started in April 1999, however, it was only somewhere in the first half of the year 2008 that it became possible to control the Total Costs of Ownership of the Blackboard VLE. It has taken DUT years to get a firm grip on the exploitation and maintenance of the Blackboard VLE and today it seems the DUT is entering what Nolan calls the control phase.

If we refer to question f "Can the VLE's growth be caught in rate-of-change and lifespan parameters? ", posed in Section 2.4.2, we can give an affirmative answer as well.

In order to catch the growth into a formula, we took the Gompertz curve as the model we used to determine the S-curve pattern, and its variables, and used nonlinear regression as curve fitting mode. If we consider the results and take the overall mean and standard deviation of the ScienceClasses from both Communities and Courses, then the Lifespan period of the VLE systems can be assumed to be 231.1 Lifespan Months or 19.26 Lifespan Years with a Standard Deviation of 44.8 Lifespan Months or 3.73 years.

VLE's mean Lifespan is 19.26 years with standard deviation of 3.73 years

Using Rogers' Diffusion theory, see Section 2.4.1, we were able to calculate the hypothetical Lifespan Months for the several adopter categories. The theoretical percentages of achievable users for the five adopter categories Innovators, Early Adopters, Early Majority, Late Majority and Laggards are listed in Table 30. Using the 'NORMINV' formula in Excel, the number of months on the Lifespan Axis were calculated based on the mean value of 115.55 as a 50 percent value of 231.1 months and on a standard deviation of 44.8 months.

If we refer to question d "Can the critical mass of the VLE be caught?", posed in Section 2.4.1, we will advise a period of at least 3 to 5 years for an implementation grade of 10 percent for a successive concern-wide educational technology before the organisation becomes accustomed to it.

These figures indicate that addressing the critical mass, with a minimal adoption level of 10 percent, take between 3 to 5 years to institutionalise the VLE system, respectively 35 months for a Lifespan of 15.5 years and 58 months for a Lifespan of 19.3 years.

The institutionalisation of a VLE system aiming at a minimum critical mass of 10 percent adoption takes 3 to 5 years

Table 30: Estimates of Adopter Categories

Adopter Categories	Theoretical figures	Cumulative figures	Empirical Timeline
Innovators	2.5 %	2.5 %	27.7
Early Adopters	13.5 %	16 %	71.0
Early Majority	34 %	50 %	115.6
Late Majority	34 %	84 %	160.1
Laggards	16 %	100 %	231.1

Since we arrived in the 88th month of the Lifespan Period of the VLE, Rogers' bell curve should indicate a theoretical achieved area of about 27 % as is depicted in the right graph of Figure 49. The percentages were calculated using the 'NORMDIST' formula in Excel. We collected all the users from the higher education ScienceClass from the System Tracking tables of our collected datasets. According to Rogers the diffusion is dependent on the market that is operating in real time, hence we used calendar time and not the Lifespan Axis. The growth pattern for the VLE users, is presented in the left graph of Figure 49.

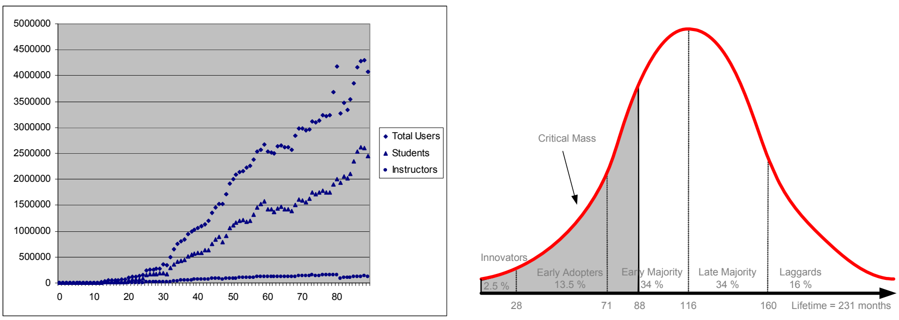


Figure 49: Left, User Growth of Collected Datasets. Right, Rogers' Distribution Curve

The number of users for our 289 collected datasets had risen to about 4 million in the 88th month of its lifespan in the calendar year 2006, for our collected datasets this should mean that in the year 2009 this growth will start to decrease. However, we had no information about the owners of the Blackboard VLE systems and their users for reasons of privacy; hence, we were not able to predict a figure as such.

Considering question e "Can the VLE's diffusion be caught in Rogers' adopter categories?", posed in Section 2.4.1, we are not capable answering it. There was not sufficient data available to give a plausible answer.

In Section 2.4, we wondered if the corporate theories of Richard Nolan and Everett Rogers could be applied to the education sector or, more particularly to higher education. This led us to formulate the first hypothesis. Using the collected empirical data we found evidence that growth figures for the Blackboard VLE match Nolan's Innovation Theory. Thus, we can prove the first hypothesis:

F3: "Higher Education VLE implementation grows along an S-shaped curve following the model a * Exp(-b * Exp(-c * Lifespan))"

with 'a' as the maximum number of courses of an institute, 'b' with the value 3.2 ± 0.2, 'c' with the value 0.037 ± 0.1, and 'Lifespan' representing the number of lifespan months.

5.3 Descriptive Analysis for Users' Uses

In our study concerning the users' uses we focussed on several subsets of the collected data. The subsets were the InstituteClass 'higher education', the ServiceClasses 'F' for 'Courses' and 'C' for 'Communities', the UserClasses '1' for 'student', '2' for 'faculty', and '3' for 'staff', and all of the 23 ActivityClasses.

We used SPSS, MS Excel and MS Access as tools for our analysis. In our search for the users' uses we had to deal with millions of data records, and this caused us to come up against the limits of the tools. SPSS can not handle more than one million parameters at one execution, while Excel can not handle more than 65,536 rows or 256 columns, and MS Access can not deal with more than 2 gigabytes of data. Having reached these limits we had to find ways to work round the problem, be it to shorten processing time or to reduce the number of records used in the analysis.

In order to present a structured overview of the users' uses we followed the indicators introduced in the Delft Case study, see Chapter 4. The indicators were 'seat time duration', 'seat time moment', and 'seat time activities', these are explored further in the next sections.

5.3.1 Indicator Seat Time Duration

The seat time duration is the time that an end user or client system is connected to the Blackboard VLE. Normally the connection time is measured with an accuracy of seconds, but for processing purposes the connection time was rounded up to minutes. A connection time of zero or '0' means that the connection time was shorter than 30 seconds, and a connection time of '1' indicates a duration between 30 seconds and 1 minute 29 seconds, and so on.

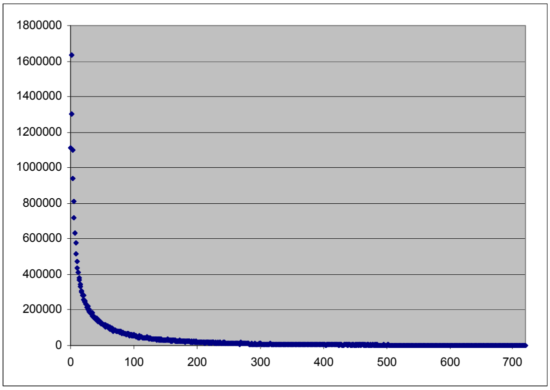


*Figure 50: Distribution Sample of Seat Time Duration in Minute Periods (N = 6.89 * 10^6 sessions)*

An indication is presented for the distribution of the seat time duration of about 6.89 million sessions from student, faculty and staff, for both Communities and Courses in Figure 50. Duration is depicted for 0 to 720 minutes on the X-axis. Longer connection times than 720 minutes, this is working hours longer than 12 hours, were being considered exceptions. In our datasets these exceptions contributed 0.45 percent of the total of samples and were deliberately ignored. In-depth investigation showed that this 0.45 percent almost always consisted of sessions with an unexplainable length. According to the Blackboard system administrators we interviewed such long sessions were due to system failures, which meant that the user's sessions could not be ended automatically. Further investigation corroborated with this idea, because in general no more than one activity was logged during such long sessions.

We divided the samples into clusters because of the vast number of data for the seat time duration. Clustering is used to group items that seem to fall together naturally (Witten & Frank, 2005). Using clustering as data-mining methods, such as k-means or nearest neighbour classification, expectation-maximization or EM algorithm, the minimum description length or MDL principle, and Bayesian clustering, we explored the data and explored it in relation to users and activities. However, all the outcomes were unsatisfactorily, due to illogical distributions or memory failures due to the tools. Thus, we chose to use a flexible built, a logical distribution to overcome these problems. The seat time duration was categorised into 13 smaller time spans. The time slots chosen were from '0 – 5' minutes, from '6 – 10' minutes, from '11 – 15', from '16 – 30', '31 – 45', '46 – 60', '61 – 90', '91 – 120', '121 – 180', '181 – 240', '241 – 480', '481 – 720', and finally slots longer than 720 minutes.

We chose such categories with more distinguished shorter periods following the distribution sample shown in Figure 50. The division was made in such way that parts could be added together to discern distributions in similar multiple time periods. For example, we started with 3 periods of five minutes each, which were then added together into a quarter of an hour, this allowed us to discern 4 time slots of 15 minutes each. Respectively we could discern 4 time slots of 30 minutes, 4 time slots of 1 hour, and 3 time slots of 4 hours length with a fourth residue collection of seat times longer than 12 hours. The SPSS syntax from Script 14, see Appendix K, represents the code for selecting the acquired data from the research base and recoding the seat time duration into the proposed categories.

5.3.1.1 Results for Seat Time Duration of Communities

We focussed on UserClasses student, faculty and staff, but we also kept the other categories in mind when we calculated the ratio percentages. These categories were: alumni, prospective student, guest, observer and dedicated institution roles. The students took about 43 percent of all the seat time duration activities while faculty took about 13 percent and staff took about 5 percent of the activities.

The UserClasses student, faculty and staff only are shown in Figure 51. The percentages of the bars in the graph are the relative shares of the activities of these 3 UserClasses divided over the time slots. The different time slots or seat time duration categories are presented on the X-axis. The seat time duration was used as a stand-alone parameter for these results which we used to discern a few characteristics for the Communities. As shown in Figure 51 about 45 percent of all activities executed during the day's work were concentrated in the first 5 minutes of the day.

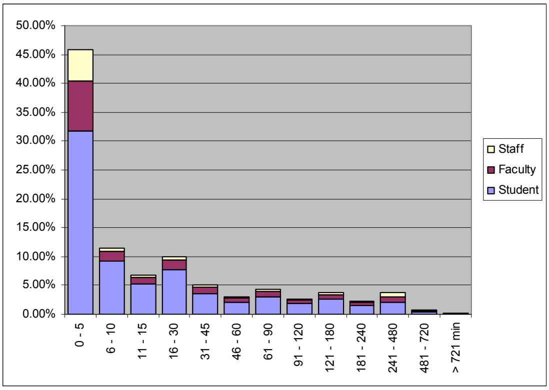


Figure 51: Seat Time Duration Percentages for UserClasses of Communities (N = 1,584,389 actions)

The clustered time slots are presented in Table 31. In the first column the 5-minute time slots were clustered into the first 15-minute time slot, this represents 64.11 percent of the total. The four 15-minute time slots together take 82.33 percent of the total. The 30-minute time slots are listed in the second column. In the third the clustered 60-minute time slots are listed while the 240-minute time slots are listed in the fourth column.

Table 31: Clustered Time Slots for Student, Faculty and Staff of Communities (N = 1,584,389 actions)

Duration	15 min	30 min	60 min	240 min
0 - 5 min				
6 - 10 min				
11- 15 min	64.11%			
16 - 30 min	10.05%	74.16%		
31 - 45 min	5.12%			
46 - 60 min	3.04%	8.16%	82.33%	
61 - 90 min		4.34%		
91 - 120 min		2.68%	7.03%	
121 - 180 min			3.76%	
181 - 240 min			2.22%	95.33%
241 - 480 min				3.73%
481 - 720 min				0.70%
> 721 min				0.24%
Totals	**82.33%**	**89.35%**	**95.33%**	**100.00%**

As can be seen from Table 31 about 64 percent of all the activities were done in the first 15 minutes, and about 74 percent of the activities were done in the first half hour of a workday. The first work hour held about 82 percent of all the activities during a workday. Moreover, if we look at the activities over a complete workday than more than 99 percent of the sessions are executed in the 8-hours standard workday of which about 95 percent were done in the first 4 work hours.

5.3.1.2 *Results for Seat Time Duration of Courses*

We also focussed on the UserClasses student, faculty and staff for the Courses. The students took about 74 percent of all activities while faculty took nearly 8 percent and staff took 2 percent of the activities.

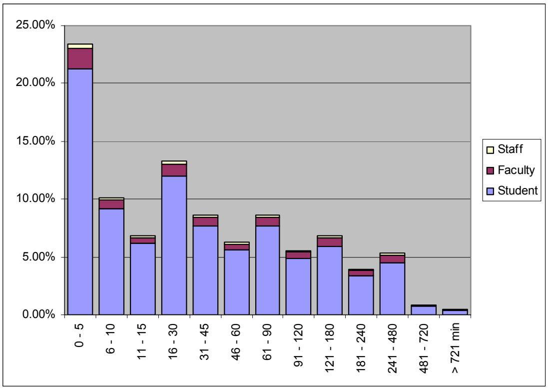


Figure 52: Seat Time Duration Percentages for UserClasses of Courses (N = 89,728,955 actions)

The UserClasses student, faculty and staff for Courses are presented in Figure 52. The seat time duration categories are shown on the X-axis and on the Y-axis are the percentage shares divided over all of the time slots. We were also able to discern a few characteristics for the Courses. About 23 percent of all activities executed during a day's work were concentrated in the first 5 minutes.

From Table 32 we can see that about 40 percent of all the Course activities were done in the first 15 minutes of the workday and about 54 percent in the first half hour. The first work hour held about 69 percent of all the activities of a work day, and if we look at the activities for a complete workday than nearly 99 percent of the sessions were executed in the 8-hours standard work time.

Table 32: Clustered Time Slots for Student, Faculty and Staff of Courses (N = 89,728,955 actions)

Duration	15 min	30 min	60 min	240 min
0 - 5 min				
6 - 10 min				
11- 15 min	40.34%			
16 - 30 min	13.32%	53.67%		
31 - 45 min	8.59%			
46 - 60 min	6.23%	14.83%	68.49%	
61 - 90 min		8.57%		
91 - 120 min		5.52%	14.09%	
121 - 180 min			6.80%	
181 - 240 min			3.94%	93.32%
241 - 480 min				5.34%
481 - 720 min				0.88%
> 721 min				0.45%
Totals	**68.49%**	**82.59%**	**93.32%**	**100.00%**

5.3.1.3 *Conclusion for Seat Time Duration*

Seat time duration is the length in minutes of a logged session. Activities take place within a session, which are logged by the Blackboard VLE. Many of these activities are done right after a user has logged on. This seems logical, because the user probably has a goal to fulfil. Logging in to the VLE system just to log-in seems to be a bit pointless, but we must not rule out such behaviour. If we study the figures for the seat time duration then we may assume that the work hours of student, faculty and staff consist of a normal work shift of about 8 hours. An additional in-depth study showed that the VLE users work an approximate 8-hour work day despite how they spread sessions over the day.

Students, faculty and staff have normal 8-hour workdays but spread over the day

In the former sections we looked at seat time duration as a stand-alone parameter, but duration as such does not stand on its own. During on online session, one to many activities were undertaken by the user within one and the same session. The seat time duration of such a session is more or less dependent of the user's activities during that session and thus we needed to explore the number of activities executed by a user within one session. We explored the seat time durations for sessions with only 1 activity, for sessions with 2 activities, with 3 activities, and so on. The variable holding the number of activities within the session was called SessionTotal. In Table 33 SessionTotal shows us that 816 different totals of activities existed within the 6.89 million sessions. The minimum number of activities was 1 and the maximum an incredible 9,337 activities within one carried out session.

Table 33: Number of Activities for Seat Time Duration for Student, Faculty, Staff of Communities and Courses (N = 6.89 * 10^6 sessions)

	N	%	Minimum	Maximum	Mean	Std. Deviation
SessionTotal	816	100	1	9,337	482.36	536.408
Valid N (listwise)	148	18				
C1 Comm student	264	32	1	472	33.17	66.420
C2 Comm faculty	213	26	1	603	41.69	104.771
C3 Comm staff	195	24	1	884	44.90	115.640
F1 Course student	762	93	1	19,116	184.58	773.711
F2 Course faculty	525	64	1	7,196	96.73	340.038
F3 Course staff	444	54	1	8,990	98.36	439.774

When we looked at the one to many activities within sessions it was striking that with up to 50 educational activities the connection time remained considerably low. This indicates zapping behaviour just after logging in and can probably be explained by the users' innate curiosity to know the latest topic matter with respect to enrolled Courses or instruction. The first 200 values of the SessionTotal with their corresponding 1 to 200 session activities were present in almost all six collections. After that a much more spread distribution occurred for the different subsets. The Valid N (listwise) stands for sessions with the same amount of activities in all subsets, meaning that 148 SessionTotals or 18 percent with a comparable number of activities were present in all of the six data subsets.

Immediately after logging-in every VLE user follows a zapping behaviour.

When we looked at the seat time duration, expressed in minutes, the variable N presents the different totals of logged durations and their percentual distribution over all collected datasets. The subsets for the ServiceClasses Communities (C) and Courses (F), and for the UserClasses student (1), faculty (2), and staff (3) are listed in the lower part of Table 33. All the subsets have a minimum value of 1 minute, the maximum values presented indicate the longest sessions, but as we have seen in the former section, we should ignore these because such long sessions were due to system failures. The seat time durations of Table 33 were queried with Script 15 to compose the overview, see Appendix K.

The mean and standard deviation of Table 33 indicated a non-normally distributed collection, so we focussed on the mode and counted the values that were most common within the connection times of seat time duration. The box plot diagrams in Figure 53 represent the six data subsets for these seat time durations. The box plot diagrams show the spread of just the one variable seat time duration. The bold horizontal line within the box represents the median or the 50th percentile value for the seat time duration. The little circles are outliers and the stars are extremes.

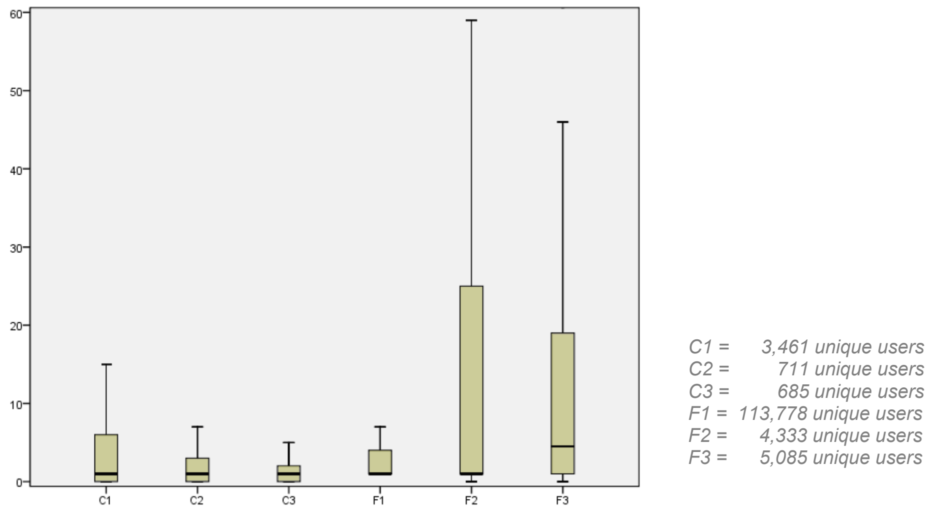


Figure 53: Box Plot Diagram of Seat Time Duration for Communities and Courses of Student, Faculty and Staff

Students conduct longer sessions in Communities compared to Courses.

All participants show a zapping behaviour (many clicks) just after logging in.

If we study Figure 53 then we see that students are connected longer when doing activities for communities than when doing activities for Courses. The whiskers presenting the 90th percentiles are 15 minutes and 8 minutes respectively. We therefore may assume that the online communication component seems to take a significant part when connected to the VLE. If we compare the medians of the three Community subsets than we see that they are of the same value, namely 1 minute. The 25th percentile is on 0 minutes and the 75th percentile is 7 minutes for the students, respectively 0 and 3 minutes for faculty, and 0 and 2 minutes for the staff. The value of 0 means 1 to 29 seconds, which indicates short sessions, probably used only to check or read messages, however, the students tend to take more time to write messages or just wait longer to reply or maybe they have more messages to answer.

> *The median communication time is 1 minute for all community users.*

The students tend to do many short but occupied sessions within the Courses. This may suggesting a zapping behaviour for checking multiple Courses and announcements. Their 25th percentile and median are at 1 minute and their 75th percentile is at 4 minutes. Faculty seems to work in a more structured way within their first hour of connection. The upper whisker or the 90th percentile, which lies in the 59th minute, indicates this, however, both the median and 25th percentile also lie within the first minute, which means that some sort of zapping behaviour was conducted after logon also, just as the students did. The staff use is more spread, with a median value on 5 minutes.
The median communication time is 1 minute for all community users. Does that mean synchronous discussions? We do not know because of the anonymous data, it is interesting for further study.

> *Faculty and staff conduct longer sessions for courses.*

Both faculty and staff for Courses suggest that longer sessions are executed when working on structural tasks. To test such assumptions we needed to know what sort of applications were called within the sessions. This will be discussed in Section 5.3.3.

5.3.2 Indicator Seat Time Moment

The seat time moment indicates the moment of the day when a session is initiated. A session is started when a user logs in; a real time calendar timestamp is logged and a unique session number is assigned to the `ACTIVITY_ACCUMULATOR`. The applications, which are called through the handles, are registered up to the moment of logging-out or up to the automated session break of 3 hours idle. We synchronised the work hours for the different datasets to compare log-ins for the same local clock hours, this was because we collected our 289 datasets from many unknown owners.

After collecting the results for the seat time moment as such, we chose to combine the seat time moment with the seat time duration to determine at which moment of the day the shorter and longer sessions have been taken place. The SPSS syntax from Script 16, see Appendix K, was used to select datasets holding the seat time moment and seat time duration. The data was collected for student, faculty and staff for both Communities and Courses.

5.3.2.1 *Results for Seat Time Moment of Communities*

An overview is presented in Figure 54 for the seat time moments of Communities. The students are shown in the left graph. We collected the timestamps of all the educational activities to obtain a precise distribution. Be aware that the Y-axis of the student graph has a four times greater value than the middle and right graphs, however, these graphs are not about the numbers but the spread pattern, this is what is important for our analysis. The figures for faculty are presented in the middle graph while the figures for staff of the Communities are presented the right graph.

Community Students = 3,461 unique users
Community Faculty = 711 unique users
Community Staff = 685 unique users

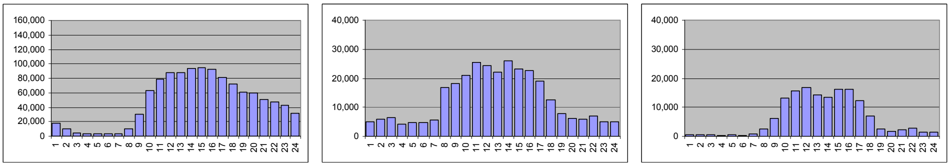


Figure 54: Seat Time Moment for Student, Faculty and Staff of Communities

If we consider the graph of the students we can see that the work hours are distributed mainly between 9 o'clock in the morning to 1 o'clock in the night. There is a peak time concentrated in the afternoon. Looking at the faculty we see a rather different signature over the 24 hours of the day, it is obvious the majority of faculty concentrate their work hours into office hours. One possibility for the '24-hours work round the clock days' is that faculty members can log in from other countries when at conferences or working at foreign universities. There is a noticeable lunch break for both faculty and staff. The right graph is even more straightforward, staff work from 9 to 5 with a visible break at lunch time.

5.3.2.2 *Results for Seat Time Moment of Courses*

We did the same exercise for Courses as we did for Communities. The overview is presented in Figure 55 for the seat time moments of the Courses. The students are presented in the left graph. Here the full occupation over day and evening hours is striking. Be aware that the values on the Y-axis of the student graph are seven times greater than those of the middle and right graphs.

Course Students = 113,778 unique users
Course Faculty = 4,333 unique users
Course Staff = 5,085 unique users

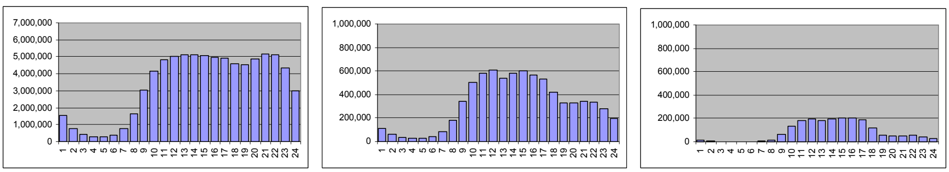


Figure 55: Seat Time Moment for Student, Faculty and Staff of Courses

Students distribute their 8-hour shifts over 18 hours of the day, indicating a flexible attitude to work.

Students distribute their 8-hours work days over about 18 hours of the day. The majority of them concentrate their work in the period from 7 o'clock in the morning to 2 o'clock in the night. During dinner time there is a slightly decrease in the number of logged-in users, but use picks up to 23:00 hours. Only after 11 o'clock in the evening does the number of students decrease with a low at 5 o'clock in the morning, but they never seem to sleep. Or maybe they are logging-in from foreign countries.

About half of the faculty work structurally in evening hours.

The middle graph presents the faculty of Courses and they also work to late at night. At lunchtime there is a small dip in the number of logged-in users and after dinner time about 60 percent of the faculty remain online. The staff are presented in the right graph, it is obvious that they mainly work during the office hours, although some little activities are shown up to 11 o'clock in the evening.

5.3.2.3 *Conclusion for Seat Time Moment*

No matter at what time maintenance takes place. There is always a user online

The Blackboard VLE is used around the clock despite the fact that the seat time durations indicate 8-hour workdays. Significant numbers of students and faculty work around the clock when doing sessions for communities or courses. Staff work mainly during office hours. If we remember that the students complain when a VLE is not available due to maintenance outside office hours, as decribed in the introduction of Chapter 4, then such distributed behaviour might explain the complaints even when system maintenance is done in the early morning, late evening or during weekend hours.

Shorter and longer sessions for students are similarly distributed all day round.

In order to get a feel for the seat time moment in combination with the seat time duration in Figure 56 an overview is presented for student, faculty and staff of the Communities. The relative percentages are depicted for all 24 hours of the day. Although the distributions of the figure were a bit fuzzy we were able to discern some patterns. The legend is added to explain which colour is related to which duration in the right graph. The students followed a quite similar duration behaviour over the 24 hours of the day. About 60 percent of student uses were sessions shorter than a quarter of an hour. The distributions for faculty and staff differed markedly when working at non-office hour use. Faculty worked in longer sessions during the night or from foreign places while staff only checks and reacts in very short sessions. Note: we must take in consideration that the small number of data points for the nightly hours may not be representative for the sample.

Community Students = 3,461 unique users
Community Faculty = 711 unique users
Community Staff = 685 unique users

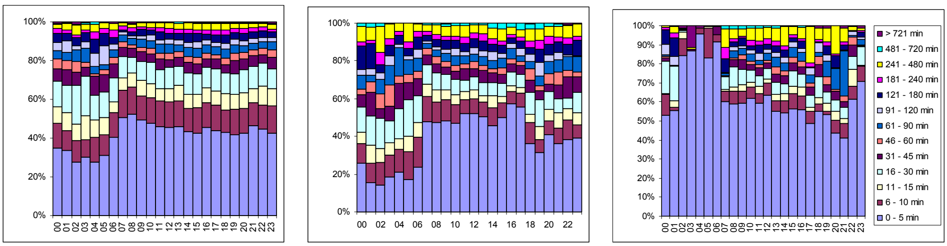


Figure 56: Overview Seat Time Duration over 24 hours of the Day for Communities

The graphical overviews of the figure are represented in Table 34 with the mean and standard deviation values for student, faculty and staff of the Communities.

Table 34: Seat Time Duration Mean and Standard Deviation for Communities

	Comm Student		Comm Faculty		Comm Staff	
Seat Time Duration	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
0 - 5 min	41.63%	7.02%	38.05%	13.85%	62.87%	14.74%
6 - 10 min	12.49%	1.29%	9.79%	2.64%	6.25%	3.17%
11 - 15 min	7.91%	1.43%	5.91%	1.68%	2.68%	2.01%
16 - 30 min	11.99%	2.89%	10.32%	3.87%	6.48%	4.69%
31 - 45 min	5.78%	1.52%	6.66%	2.71%	2.98%	2.00%
46 - 60 min	3.15%	0.99%	4.14%	2.15%	1.73%	1.49%
61 - 90 min	4.19%	0.93%	5.98%	2.73%	3.78%	5.09%
91 - 120 min	3.17%	1.85%	3.15%	1.48%	2.07%	1.70%
121 - 180 min	3.80%	1.25%	5.47%	2.63%	2.98%	2.75%
181 - 240 min	2.18%	0.65%	2.96%	1.12%	1.46%	1.32%
241 - 480 min	2.87%	0.76%	6.05%	2.19%	5.39%	4.82%
481 - 720 min	0.48%	0.22%	1.35%	0.97%	0.45%	0.57%
> 721 min	0.38%	0.31%	0.18%	0.20%	0.88%	2.30%

We did the same exercise for Courses as we did for Communities. An overview of the seat time duration versus the seat time moment is presented in Figure 57 for the student, faculty and staff of Courses. The relative percentages are depicted for a 24-hour day.

Course Students = 113,778 unique users
Course Faculty = 4,333 unique users
Course Staff = 5,085 unique users

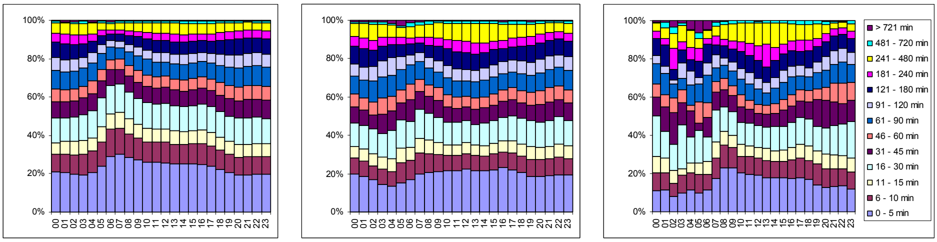


Figure 57: Overview Seat Time Duration over 24 hours of the Day for Courses

Table 35: Seat Time Duration Mean and Standard Deviation for Courses

	Course student		Course faculty		Course staff	
seat time duration	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev
0 - 5 min	23.53%	3.42%	19.51%	2.56%	15.31%	4.23%
6 - 10 min	10.63%	1.29%	8.61%	0.96%	9.39%	1.12%
11 - 15 min	7.01%	0.61%	6.40%	0.63%	6.57%	1.08%
16 - 30 min	13.49%	0.58%	12.91%	1.20%	14.41%	3.10%
31 - 45 min	8.61%	0.43%	8.65%	1.01%	9.92%	3.00%
46 - 60 min	6.19%	0.59%	6.57%	0.79%	6.56%	1.96%
61 - 90 min	8.60%	1.22%	9.28%	0.88%	8.84%	1.89%
91 - 120 min	5.35%	1.05%	6.52%	0.93%	5.56%	1.45%
121 - 180 min	6.51%	1.41%	7.81%	1.12%	7.89%	1.34%
181 - 240 min	3.78%	0.78%	4.60%	0.77%	5.43%	2.24%
241 - 480 min	4.95%	0.87%	7.18%	1.65%	7.52%	2.89%
481 - 720 min	0.84%	0.15%	1.20%	0.28%	1.48%	0.78%
> 721 min	0.49%	0.10%	0.75%	0.53%	1.10%	1.75%

Shorter and longer sessions for courses are similar all day round for faculty and staff.

If we study the graphs from Figure 57 then it is striking that the distributions of all three subsets, student, faculty and staff, are much more in proportion. The large number of data points compared to the figures of the Communities presents a much smoother distribution. We can be confident that a same distribution as for the seat time duration, see Section 5.3.1.2, is followed for the workday. The graphs are represented in Table 35 by their mean and standard deviation values.

It is now time to explore what the student, faculty and staff were really doing during the sessions discussed above.

5.3.3 Indicator Seat Time Activities

The seat time activities are the actions undertaken by the users when connected to the VLE. We explored what activities were conducted. The SPSS syntax from Script 17, see Appendix K, was to select the data subsets holding the seat time activities that were bound to the seat time moment and seat time duration. The data was collected for student, faculty and staff for Communities and Courses.

Although the seat time activities are logged separately there are some typically related activities. For instance the *cp_discussion_board*, *discussion_board_entry* and *discussion_board* are more or less dependent. The *cp_discussion_board* indicates that a new message or discussion is initiated. The *discussion_board_entry* is used to react on such messages with an answer or thread and the activity *discussion_board* means that the message is read. As second example the *cp_gradebook* is used to upload figures and grades, while *check_grade* indicates reading the gradebook.

Community Students = 3,461 unique users
Community Faculty = 711 unique users
Community Staff = 685 unique users

We described the different activities in Chapter 4, how they were logged, and categorised into five clustered categories: Course-oriented, Comm-oriented, Presentation, Messaging and Tooling. In the following sections we will present the figures for the activities and for the activities taken together within their categories.

5.3.3.1 Results for Seat Time Activities of Communities

We collected the seat time activities for the students, faculty and staff. The absolute numbers of the logged activities corrected for the total numbers of students, faculty and staff were presented in Section 5.1.4. This correction was made to present proportionally distributed activities; in other words the number of actions per type of user for the different ActivityClasses.

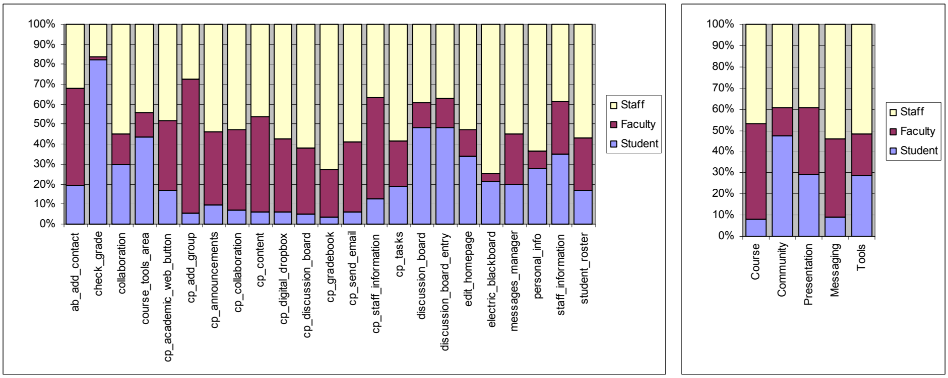


Figure 58: Overview of 23 Activities for Student, Faculty, Staff for Communities, Single and Clustered

An overview for the relative distribution of the three InstitutionRoles is presented in the left graph of Figure 58 per graphed bar for the Communities. The relative shares of faculty and staff are large, which means that they have to execute many actions to let the VLE operate. The typical student activities and the more faculty and staff activities are relatively easily to discern. The five clustered categories are presented in the right graph of Figure 58. Courses and messages are the instructor activities that match with the outcomes of our explorative case, where efficiency and ease of use motivated the instructors to use the courses and messages. The students' shares increase for community, presentation and tools but remain considerably smaller than the faculty and staff shares.

5.3.3.2 Results for Seat Time Activities of Courses

We also collected the seat time activities for the Courses. All of the 23 activities are presented in the left graph of Figure 59. If we compare the course shares then those for staff are larger than for the Communities.

The faculty's work is concentrated on the 'cp_' activities. Instructors do have a lot of actions to do to keep the VLE going.

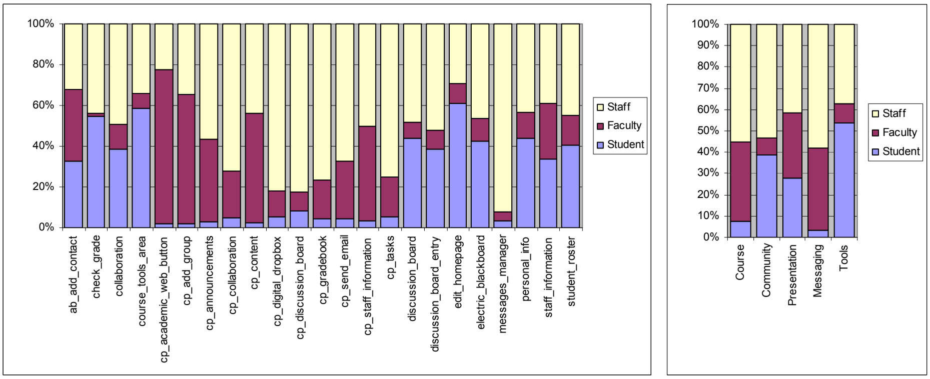


Figure 59: Overview of 23 Activities for Student, Faculty, Staff for Courses, Single and Clustered

Course Students = 113,778 unique users
Course Faculty = 4,333 unique users
Course Staff = 5,085 unique users

The five clustered categories are presented in the right graph of Figure 59 for student, faculty and staff. The course-oriented and messaging activities are important for the instructor. The student shares are significant for community and tools activities.

5.3.3.3 Conclusion for Seat Time Activities

The figures for Communities and Courses show only a small difference in the uses of the activities. Faculty and staff executed many activities to operate the VLE. It is striking that they have to fulfil so many more activities than the students. It was thus obvious that student assistants were often used to help get the Communities and Courses online. The control panel activities, which are recognised with their 'cp_' prefix, are mostly restricted to instructors. However, we know from system administrators interviewed that many students had applied for assistant jobs to prepare Communities and Courses and input materials. These activities may influence the student shares of the control panel.

Student-assistants' help seems common to get Comms and Courses online

Considering the relative shares it seems only fair that instructors chose activities which 'deliver'. According to the explorative case the instructors concentrated on efficient and easy activities such as distribution of subject matter and one-to-many messaging. Faculty and staff use the *cp_announcements, cp_gradebook, cp_send_email* and *cp_staff_information* regularly to inform the VLE user, which seems consistent with the results of our DUT case where efficient usage of one-to-many messaging was highly valued by the instructors.

Content distribution is an instructor activity that pays back for its efficiency and ease of use

If we study the several figures of the seat time activities then it is striking that some activities are used very often and that most of the applications are used rarely. The relative distribution is presented in Table 36 for all of the 23 seat time activities for student, faculty and staff for both Communities and Courses. It seems fair to ignore the activities with smaller shares in order to describe typical features for the uses of Communities and Courses. However, *check_grade* is a typical student activity, but Course faculty still has a significant share. This is probably due to grade checking. We still decided to ignore it. The typical use activities are shown in bold in Table 36.

Messaging is an instructor activity where efficiency and ease of use pays back for the one-to-many messaging features.

Table 36: Overview of Relative Usage of 23 Seat Time Activities for Communities and Courses

seat time activity	Comm student	Comm faculty	Comm staff	Course student	Course faculty	Course staff
ab_add_contact	0.01%	0.01%	0.03%	0.00%	0.00%	0.00%
check_grade	**1.41%**	0.22%	0.03%	**6.04%**	2.32%	0.26%
collaboration	0.27%	0.39%	0.21%	0.29%	0.18%	0.11%
course_tools_area	**2.55%**	**2.01%**	**1.17%**	**9.41%**	2.61%	1.27%
cp_academic_web_button	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%
cp_add_group	0.05%	**0.19%**	**1.02%**	0.02%	0.18%	0.54%
cp_announcements	1.78%	**6.23%**	**11.05%**	1.12%	9.13%	15.04%
cp_collaboration	0.01%	0.06%	0.08%	0.01%	0.08%	0.06%
cp_content	2.84%	**15.23%**	**40.68%**	1.75%	14.82%	44.97%
cp_digital_dropbox	0.07%	0.53%	0.70%	0.71%	5.03%	2.08%
cp_discussion_board	**0.18%**	**1.56%**	**1.64%**	**1.98%**	9.04%	3.04%
cp_gradebook	0.14%	**2.20%**	0.76%	1.54%	11.98%	7.95%
cp_send_email	0.13%	**0.93%**	**1.07%**	0.27%	1.90%	1.99%
cp_staff_information	0.45%	**0.86%**	**3.10%**	0.09%	0.63%	1.43%
cp_tasks	0.02%	0.04%	0.03%	0.02%	0.10%	0.06%
discussion_board	**67.51%**	**49.81%**	**23.04%**	**60.13%**	31.33%	14.33%
discussion_board_entry	**17.83%**	**13.25%**	**7.63%**	**11.93%**	7.64%	3.59%
edit_homepage	0.09%	0.11%	0.05%	0.18%	0.04%	0.03%
electric_blackboard	0.05%	0.16%	0.02%	0.09%	0.05%	0.02%
messages_manager	0.01%	**0.02%**	**0.02%**	0.03%	0.36%	0.03%
personal_info	0.12%	0.21%	0.06%	0.20%	0.09%	0.08%
staff_information	**3.22%**	**2.72%**	**4.44%**	**2.58%**	1.62%	2.48%
student_roster	**1.25%**	**3.27%**	**3.15%**	**1.62%**	0.88%	0.61%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

C1 = 1,130,410 actions
C2 = 304,446 actions
C3 = 149,533 actions
F1 = 80,090,700 actions
F2 = 7,655,398 actions
F3 = 1,982,857 actions

A large share of the activities of faculty and staff is spent on obtaining content for the VLE users. The activity *cp_content* holds the highest shares, more than 40 percent for staff for both Communities and Courses. If we again refer to the explorative case then distribution of learning materials was highly valued. The discussion board activities are used most often by the VLE users. It is striking that these communication handles have such great shares in both Communities and Courses.

The discussion board is common use for Communities and Courses

Given that the different discussion board actions of 'making a message' versus 'reacting on a message' versus 'reading a message' are related, we isolated the figures and listed them in Table 37. In the top rows the percentages of Table 37 are transposed into their relative shares.

Table 37: Ratios for Discussion Board Uses of Communities and Courses

seat time activity	Comm student	Comm faculty	Comm staff	Course student	Course faculty	Course staff
Making a message	0.21%	2.41%	5.08%	2.67%	18.83%	14.50%
Reacting on a message	20.85%	20.50%	23.61%	16.11%	15.91%	17.13%
Reading a message	78.94%	77.08%	71.31%	81.21%	65.26%	68.37%
Totals	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Making a message	2.73%	31.35%	65.92%	7.43%	52.29%	40.28%
Reacting on a message	32.09%	31.56%	36.35%	32.78%	32.37%	34.85%
Reading a message	34.72%	33.91%	31.37%	37.80%	30.38%	31.82%

If we study the Community columns then we see that staff is the most active user with a 1 to 5 ratio for making and reacting on messages. faculty follows with a 1 to 10 ratio. One out in 4 students reacts on the messages. The relative shares are listed in the bottom rows for who is making, reacting and reading the messages. staff is responsible for two-third of the messages and faculty for one-third.

If we study the figures for the Courses then we see that faculty is the most active user directly followed by staff. There is a 1 to 1 ratio for making messages versus reacting to them. This indicates direct communication behaviour because 1 out of 3 to 4 readers actively join the discussion. If we study the bottom rows then we see that the Course messages are about equally divided over the users.

Communities' instructors are active message makers. There is about a 1 – 5 – 15 ratio in making, reacting and reading messages.

Another activity that is used regularly by all the users is *staff_information*, which means that checking lecturers and their administrative data adds value, for the students the *check_grade* and *course_tools_area* are important seat time activities. The *student_roster* for Communities seems to be a valuable tool for faculty and staff, and is probably to assign students into groups for collaboration purposes.

The duration data in minutes for all of the Seat Time activities is collected in Table 38. We must be aware that the figures only show the times to call an application and not the real time that is spent on for instance a reader. A typical activity that takes a long time as learner but a short time as instructor is *cp_content*. Many actions have to be executed to put subject matter online as content that is available for the student. If we compare the 'putting online handlings' versus 'reading and learning' the content, than the latter take much more brain capacity and much more time is spent on the activity. We have to consider that we only collected the calls to an application before the next action is taken in Table 38 and not the time a user spent on such an application.

Table 38: Overview of Averaged Duration in Minutes of the 23 Seat Time Activities

seat time activity	Comm student	Comm faculty	Comm staff	Course student	Course faculty	Course staff
ab_add_contact	1	1	1	2	2	1
check_grade	**15**	1	0	**6**	4	7
collaboration	11	3	7	3	4	5
course_tools_area	**3**	**7**	**3**	**5**	**3**	**6**
cp_academic_web_button	44	6	8	7	5	9
cp_add_group	4	**4**	**3**	3	**4**	**5**
cp_announcements	2	**2**	**2**	2	**2**	**2**
cp_collaloration	4	8	1	3	4	5
cp_content	1	**1**	**1**	1	**2**	**2**
cp_digital_dropbox	3	6	9	2	**3**	**4**
cp_discussion_board	**1**	**1**	**2**	**1**	**1**	**1**
cp_gradebook	4	**5**	5	3	**3**	**4**
cp_send_email	5	**8**	**10**	6	**7**	**9**
cp_staff_information	1	**1**	**1**	2	**2**	**2**
cp_tasks	1	1	1	1	1	2
discussion_board	**2**	**2**	**2**	**1**	**1**	**2**
discussion_board_entry	**3**	**3**	**3**	**2**	**3**	**4**
edit_homepage	1	3	7	2	2	3
electric_blackboard	2	1	0	2	2	3
messages_manager	1	**11**	**0**	1	**1**	**3**
personal_info	1	1	1	2	1	2
staff_information	**3**	**4**	**3**	**6**	**6**	**7**
student_roster	**1**	**2**	**2**	**1**	**1**	**4**

Course instructors are very active communicators. There is a 1 – 1 – 4 ratio in making, reacting and reading messages

If we consider the averaged duration per user per activity for the Communities and Courses and compare them to the listed values of Table 38 we are able to see which seat time activities are the ones that determine the users' uses of the VLE. Thus we set these figures bold to show the significant activities.

Putting and reading grades online take an important place in the uses of the VLE.

If we study Table 38 then it is obvious that *check_grade* is important for the student for both Communities and Courses. It is striking that Course faculty and Course staff spend a great deal of time at check-grade. This is probably to get an overview of the grades because such formal figures are important for a student passing or failing exams. The *course_tools_area* is important and used by all VLE users. The announcements are short messages as are the discussion board entries with their 1 to 3 minute durations, but email messages take up to 10 minutes, which indicates a more dedicated set up. Finally *staff_information* seems important because all of the VLE users spent significant time in reading this.

5.4 Test Analysis for Users' Uses

We will now discuss implementation for the Communities and Courses of the Blackboard VLE, which we discerned as one of the three main literature streams in Section 1.3.3. We asked if there was a connection between the evolution of the educational technology and the uses of student, faculty and staff for both Communities and Courses.

In the following section, we transpose our empirical data to a normalised form to compare it with the theories outlined in our theoretical framework in Chapter 2. First, we transposed the calendar times of the collected data to a Lifespan Axis. Secondly, we compared the uses of the seat time duration over time. We wanted to know if there were shifts in lengths of the sessions. Thirdly, we did a same exercise for the seat time moment to know if shifts have appeared for moments of the day. Fourthly, we normalised the seat time activities to the Y-Axis so we could use a nonlinear regression model. Finally, we set out conclusions concerning hypothesis 2.

5.4.1 Normalising the X-Axis from Calendar Time to Lifespan

In order to confront the theories of Chapter 2 with the empirical data for hypothesis 2 we focussed on the users' uses of the Communities and Courses from higher education. We expressed them in monthly figures as we did before with the Lifespan Axis. We normalised the data by transposing the calendar time of all Communities and Courses onto a Lifespan Axis, Figure 60 helps to explain how we did the normalisation process. We took the Course with the earliest `DTCREATED` out of our collected datasets, January 1999. This date was designated to be the first month on the Lifespan Axis. Every VLE Owner has its own VLE System Start Month in calendar time, which was converted to the first Lifespan Month on the Lifespan Axis. The Courses were counted in the Lifespan month that corresponds to the particular VLE System Start Month added to its course delay and its handle delay.

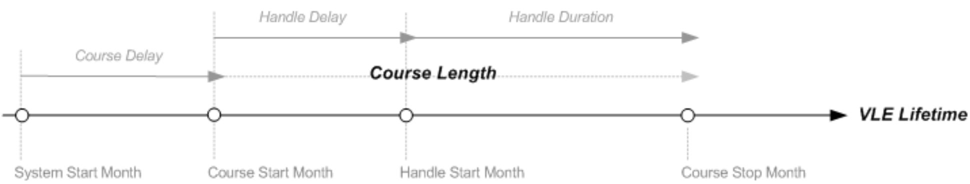


Figure 60: Schematic Overview of Composition for CourseLength and VLE Lifespan

Once we had transposed all the datasets onto the Lifespan Axis we worked out the seat time indicators for the Lifespan years to compare them with the overviews of the former sections.

5.4.2 Seat Time Duration on Lifespan Axis

The Handles in the `ACTIVITY_ACCUMULATOR` have only been logged for 3 years in calendar time, but once we had transposed the seat time duration to the Lifespan Axis we found 72 Lifespan months for the Communities. In order to discern if there had been a shift over time for the seat time duration we have collected the averaged durations for each Lifespan year with the help of Script 18, see Appendix K.

Table 39: Overview of Seat Time Duration upon Lifespan Axis for Communities

Lifespan Year	student Mean	student Std.Dev	faculty Mean	faculty Std.Dev	staff Mean	staff Std.Dev
01	45.33	79.564	191.89	185.234	91.38	126.998
02	53.29	85.410	128.39	149.318	73.21	103.122
03	41.53	68.967	41.40	83.377	111.84	140.179
04	38.07	80.082	48.85	113.296	46.01	99.575
05	32.83	73.294	43.55	93.308	4.78	22.478
06	43.54	74.594	43.21	70.619	90.97	121.879

The mean values and standard deviations of the seat time duration for Communities are listed in Table 39 for student, faculty and staff. As we can see the values of the standard deviation are greater than the averaged values meaning that the mean values are not so reliable for conclusion drawing. Over the years the students have been connected for sessions of about three quarters of an hour, while faculty worked long sessions in the first 2 Lifespan years, followed later by sessions of three quarters of an hour. The values for staff are more from very short to about two hours.

If we compare the mean values of Table 39 not much has shifted in length for the durations over Lifespan years. The averaged duration of a session remained the same for different student cohorts for 6 years, which means that the work hours and distributed durations are more or less standard behaviour for students in general. Every year's new student cohort follows the same duration behaviour. Faculty, however, shows a shift from very long working sessions in the first two years to a more responding attitude in the following years. Staff has followed a more dispersed behaviour. In order to generate separate curves for student, faculty and staff we have set Script 19 to work, see Appendix K.

> *Community session durations remain about the same over a lifespan of 6 years for different student cohorts.*

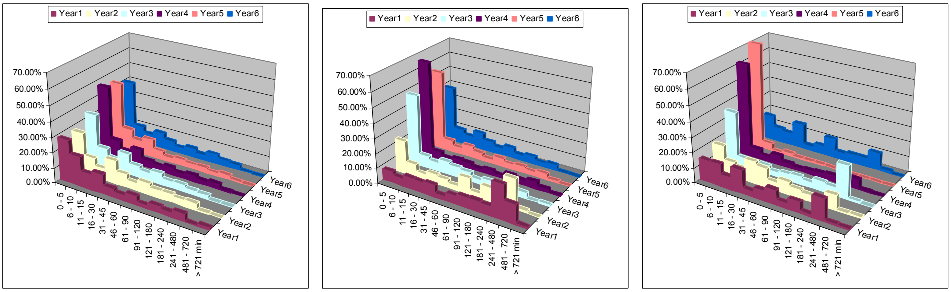


Figure 61: Overview of Seat Time Duration Percentages for UserClasses per Lifespan Years for Communities

The seat time duration values for student, faculty and staff are presented graphically in Figure 61 with separate lines for every one of the 6 Lifespan years. The middle graph presenting faculty shows long work sessions for the first 2 years. In the following 4 Lifespan years the long sessions level out. The same counts for the right graph for staff although in a much smaller way.

> *Community session durations for Faculty and Staff show long working days in the first two years.*

Table 40: Overview of Seat Time Duration upon Lifespan Axis for Courses

Lifespan Year	student Mean	student Std.Dev	faculty Mean	faculty Std.Dev	staff Mean	staff Std.Dev
01	81.51	1187.117	116.79	131.011	157.25	160.295
02	116.06	4677.983	82.16	110.665	84.38	111.155
03	95.89	3033.437	63.58	105.600	86.19	114.541
04	103.07	3889.804	74.98	113.767	87.89	113.226
05	94.23	2727.229	62.53	94.470	80.59	115.085
06	83.14	1205.945	82.60	106.604	111.59	131.896
07	81.75	782.043	86.44	104.038	110.41	123.716

We carried out the same process for the seat time duration of the Courses. The mean and standard deviation are listed in Table 40 for the Lifespan years. The transposition from calendar axis to Lifespan axis gave 87 Lifespan months or more then 7 Lifespan years for Courses. We calculated the mean and standard deviation values for seat time duration, all of the standard deviation values are much larger than the mean values, which

> *Course session durations remain the same over a lifespan of 7 years for different student cohorts.*

indicates that the mean values are not so definite. Still the values give us an idea of the yearly averages. The students spend about 1.5 to 2 hours online per session. Faculty started with 2-hour sessions in the first Lifespan year, then it decreased to 1.5 hours per session. Staff started with 2.5-hour sessions, which decreased to 1.5 hours. As we can see only small shifts have taken place for the Courses over the years.

Next we have set out all the time slot categories per user to obtain an idea of the duration distribution. As the left graph of Figure 62 shows there are no noticeable changes for the students for the 7 Lifespan years. Faculty and staff spent time in many long sessions in the first year, probably to put the subject matter online, from the second year session length reduced with sessions of an hour and longer.

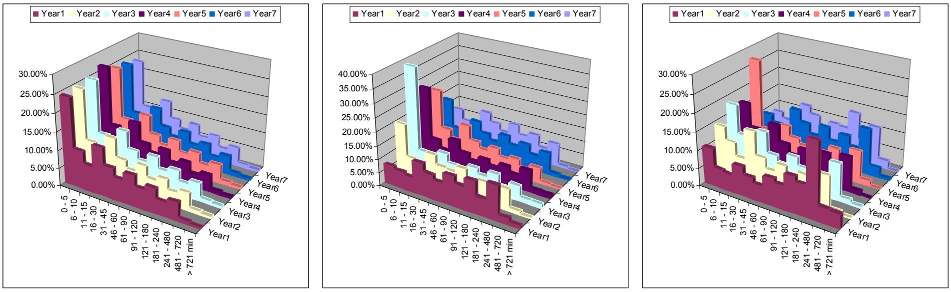


Figure 62: Overview of seat time duration Percentages for UserClasses per Lifespan Years for Courses

Concluding Remarks

If we study the figures for Communities and Courses then the students are quite stable in their online connected behaviour, the distribution of the seat time duration remains about the same over the years. The different cohorts of students show almost no differences in the seat time duration categories. Staff, however, started with long work sessions, probably to make sufficient subject matter available for their Communities and Courses within the Blackboard VLE. In the first year especially much of what we have called structural work was done. Structural work is the instructor's effort to prepare an online course with its content, its meta-information, its announcements and its assignments. In the following years, more spread behaviour was observed with medium long sessions and short sessions.

> *Course session durations for Staff show long working days in the first year.*

5.4.3 Seat Time Moment on the Lifespan Axis

We compared the figures for the seat time moment over the Lifespan years. Using Script 19, see Appendix K, we collected the data to generate appropriate curves. The Communities values for the 6 Lifespan years are represented by the separated curves in Figure 63. As we can see in the left graph the students focus work in office hours and evening hours. Although the students' seat time moment decreases as evening moves into the night, it is never zero, which contrasts the middle graph of faculty and the staff right graph.

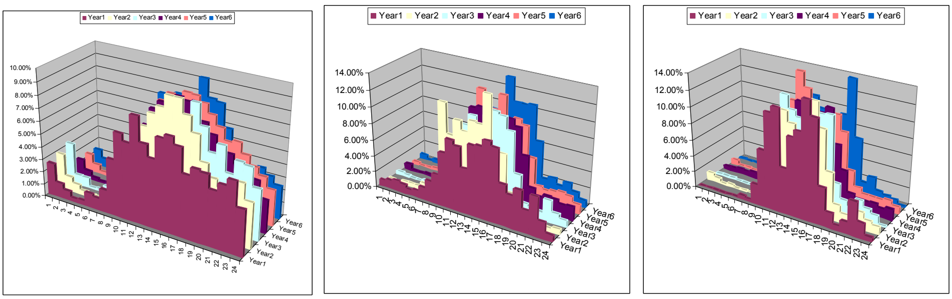


Figure 63: Overview of Seat Time Moment for Student, Faculty and Staff per Lifespan Years for Communities

In the first Lifespan year the seat time moment for faculty extended into the evening. In subsequent years the evening work shifted to full office hours. However, some faculty still work in the evening. It is not clear if this work was done locally or for instance from foreign places, such as conferences and other foreign universities, the work also might refer to evening classes. A less marked but similar behaviour is visible for staff; the first year saw some evening work, but work done in the following years remains within office hours.

The seat time moments for the Courses are depicted in Figure 64. When we look at the curves for the left students' graph, we can see that there has been no change over the years. A straight distribution has been followed for 7 Lifespan years. It appears that the seat time moment of the students over the 7 years has remained steady as the seat time duration for the students, and that the students use the evening hours on the Blackboard VLE.

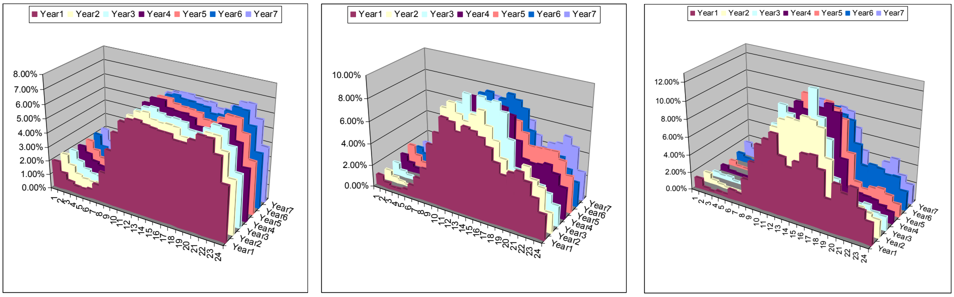


Figure 64: Overview of Seat Time Moment for Student, Faculty and Staff per Lifespan Years for Courses

The working behaviour of faculty also remained quite steady over the evening hours. The evening hours appear to be a structural working period. There was little shift or growth to or from the evening hours over the years for faculty. Staff do some work outside the office hours too, however, evening work has levelled out in the later years.

Concluding Remarks

There seems to be a online working ethic that stretches from normal office hours to 18-hours full usage of the Blackboard VLE, and users can be found online around the clock. The working day is an averaged 8-hour shift, but we do not know if this distribution over the day is caused by working flexible hours, work from foreign places where the clock hours are different, or due to evening classes, or is it an expression of the 24-hour economy. What is important is the fact that the VLE system has to be online all the time, thus the owner institutes have to take care that their VLE systems are robust and reliable. It is also clear that in the first 2 years of a VLE's Lifespan faculty and staff have an enormous job to do to put subject matter online, and that this is done with the help of student assistants.

> *Users can be found online around the clock, demanding the institute to service a robust and reliable VLE system.*

5.4.4 Seat Time Activities on the Lifespan Axis

Finally we set out all 23 seat time activities for the Lifespan years using Script 19. The activities for the Communities are depicted in Figures 65 to 67. In the students' graph of Figure 65 we can see small increases and decreases for a few activities, but these activities remain the same over the Lifespan years. There were no changes in activities. The significant activities match the figures presented in Table 36. The increase in the student's shares for *announcements*, *content* and *staff_information* in year 6 is striking. Were the old-year students helping newly hired instructors or laggards? We do not know.

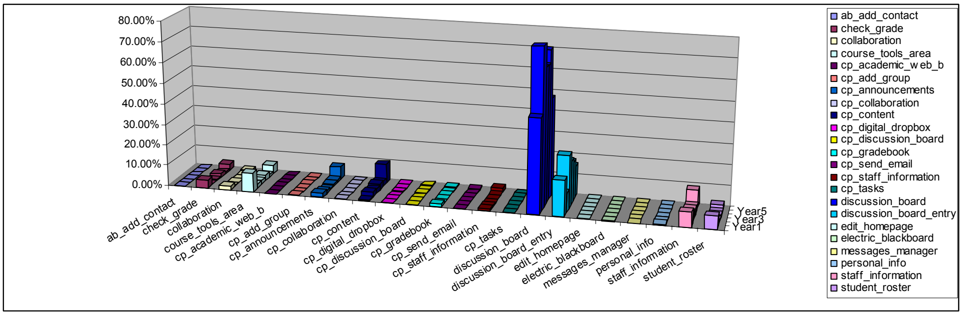


Figure 65: Activities per Lifespan Years for Community Students

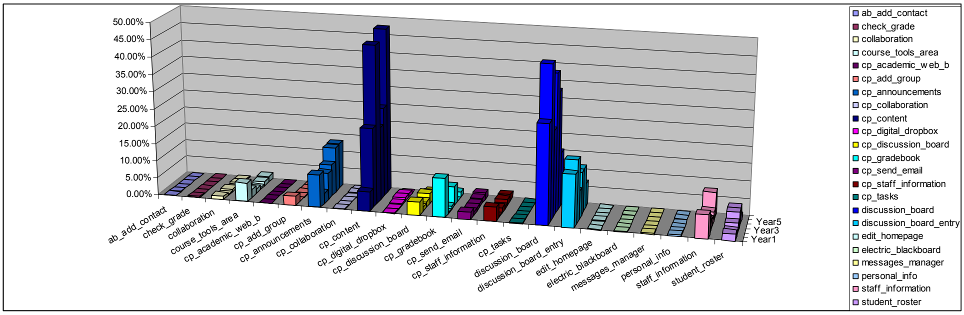


Figure 66: Activities per Lifespan Years for Community Faculty

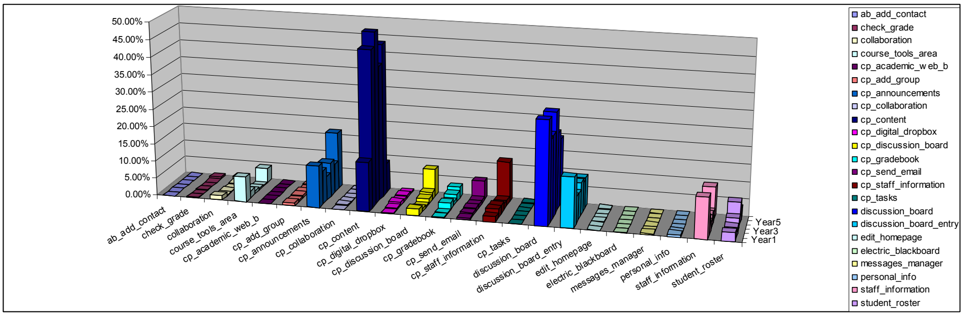


Figure 67: Activities per Lifespan Years for Community Staff

In the faculty's graph of Figure 66 a focus shift is visible from *course_tools* and *gradebook* to *content* in the first year and from *discussion_board* to *content* in the later years. In the staff's graph of Figure 67 a focus shift is visible from *discussion_board* to *content*, although a parallel shift from *reading* to *discussion_board making* occurred. *Announcements* and *staff_information* have also increased in later years. In general it seems that in the first years, the Communities are used as they were meant to be, but over the years Course characteristics have come into play. On average the ratio for making, reacting and reading messages for the discussion board is about 1 to 5 to 10 over the years.

We also set out the graphs for the Courses. If we study the students' graph in Figure 68 then it is obvious that there was no change in seven Lifespan years. The curves of the separate years follow the same path. The faculty's graph in Figure 69 shows a focus shift in the 2nd year from *gradebook* to *content*. In parallel *discussion_board* uses have increased steadily although the making of new messages decreased, still it indicates a continuing ratio over Lifespan years of about 1 to 1 to 4 for making, reacting and reading. In years 6 and 7 a shift occurred from *content* in favour of *gradebook, announcements* and *discussion_board* making activities. The other activities remained more or less the same, although small decreases occurred in *digital_dropbox* and *send_email* in favour of *check_grade* and *course_tools*, that were undone in the later years. In the staff's graph of Figure 70 a shift from *gradebook* and *discussion_board* reading to *content* and *announcements* can be seen from the 2nd year on, however in year 6 and 7 *content* decreased in favour of *gradebook* and *discussion_board* activities. The approximate *discussion_board* ratio for making, reacting and reading is about 1 to 1 to 4 over the years.

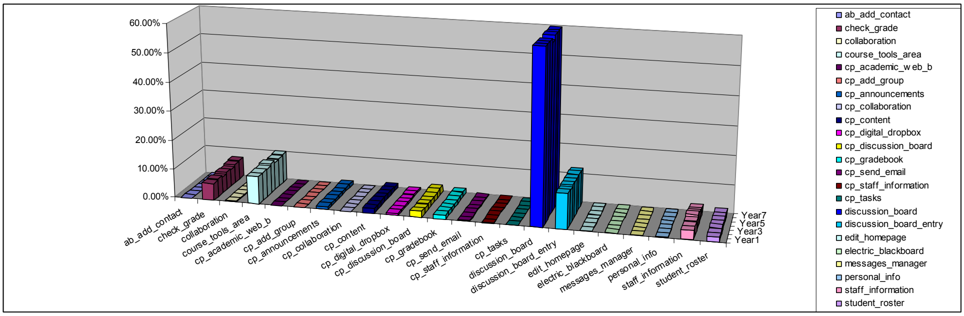


Figure 68: Activities per Lifespan years for Course Students

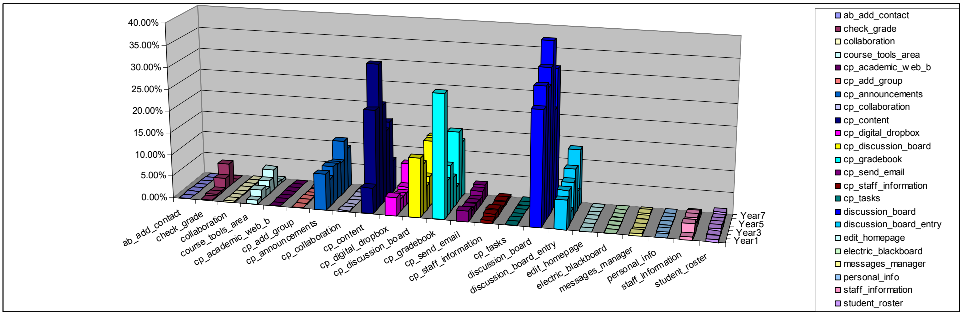


Figure 69: Activities per Lifespan Years for Course Faculty

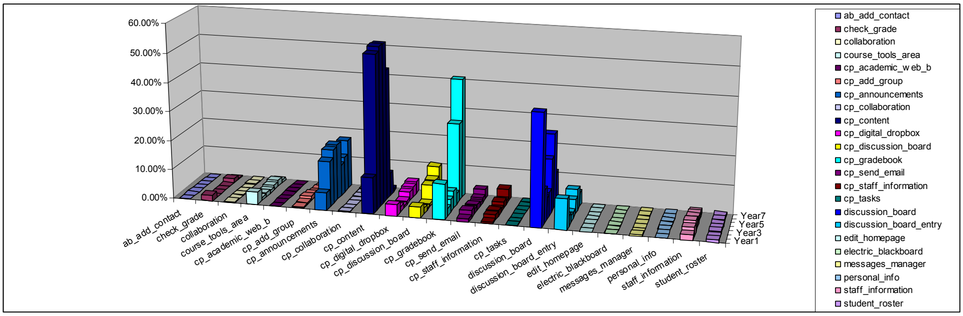


Figure 70: Activities per Lifespan Years for Course Staff

Concluding Remarks

Different student cohorts over the years show a remarkable straight way of online working with the Blackboard VLE.

If we study the figures than it is striking that the students show a remarkable straight way of online working with Blackboard VLE. There has been little change over the Lifespan years, although every academic year new students enter the universities. In contrast to the students we see changes in focus for both faculty and staff. The same activities have remained significant over the years but with an increasing or decreasing focus.

The most striking observation is that Communities show a change from communication focussed activities to content based activities and that the Courses show a shift from content based activities to more communication oriented activities. These shifts are crucial because they indicate that pedagogies built around the VLE are shifting from content-based courses to mixed practices of content and communication. If we realise that such online pedagogies are combined with offline education in blended practices than we may assume, that with the help of VLE technologies, education in general is reforming. Since online communication can be stored and therefore available and visible for others asynchronously, such information holds a sharing component despite the still mostly unstructured VLE's presentation. Social software systems are better equipped to share such online communication in for instance blogs, wikis and portals.

Comms show a change from communication focussed activities to content based activities over the years.

Courses show a shift from content based activities to more communication oriented activities over the years.

5.4.5 Normalising the Y-Axis for Communities and Courses

The Classification Schema was presented in Figure 29 of Chapter 4, this was used to order all the data for our collected datasets. The schema presented amongst others 4 InstituteClasses, 3 ServiceClasses, 8 UserClasses and 23 ActivityClasses from 289 Owners. We used higher education from the InstituteClass, Communities and Courses from the ServiceClasses, student, faculty and staff from the UserClasses, and we used all of the ActivityClasses. In our way of work we studied the ActivityClasses for Communities and Courses and for student, faculty and staff separately.

Table 41: Estimates of Curve Fitting for Uses of Communities

UserClass	Student				Faculty				Staff			
ActivityClass	a	b	c	R^2	a	b	c	R^2	a	b	c	R^2
ab_add_contact	1.174	13.77	0.068	0.981	0.790	5.720	0.076	0.898	0.967	6891	0.276	0.977
check_grade	0.929	1360	0.193	0.983	2.392	3.278	0.019	0.966	1.344	3.463	0.038	0.912
collaboration	1.058	34.64	0.098	0.964	1.073	4.063	0.052	0.974	1.293	3.233	0.041	0.958
course_tools_area	1.064	9.805	0.068	0.987	1.095	3.379	0.037	0.964	1.070	5.206	0.069	0.988
cp_academic_web_b	0.959	28.05	0.177	0.983	1.728	6.397	0.038	0.948	0.912	52259	0.637	0.990
cp_add_group	1.559	5.182	0.035	0.996	0.867	4.838	0.098	0.977	0.994	13.17	0.138	0.987
cp_announcements	1.499	5.586	0.038	0.989	0.870	4.285	0.055	0.939	1.029	7.526	0.088	0.994
cp_collaboration	1.432	4.376	0.036	0.980	0.963	53.98	0.156	0.937	1.696	1.539	0.017	0.899
cp_content	1.110	9.978	0.059	0.990	0.941	4.294	0.051	0.957	1.022	10.34	0.106	0.991
cp_digital_dropbox	0.991	79.29	0.123	0.977	0.872	14.46	0.096	0.972	1.034	2.993	0.088	0.963
cp_discussion_board	0.963	6.787	0.076	0.971	0.983	5.800	0.080	0.990	0.988	10.09	0.101	0.995
cp_gradebook	1.058	17.84	0.082	0.980	0.920	2490	0.648	0.962	1.020	1078	0.204	0.985
cp_send_email	1.149	6.416	0.052	0.993	0.842	6.477	0.079	0.964	1.025	11.19	0.093	0.989
cp_staff_information	1.623	4.932	0.033	0.985	1.022	3.611	0.045	0.969	1.022	2.590	0.051	0.979
cp_tasks	1.085	5.367	0.054	0.977	0.982	4.557	0.064	0.979	0.906	14.25	0.114	0.980
discussion_board	0.975	23.01	0.136	0.995	0.931	15.82	0.142	0.994	1.027	13.88	0.107	0.995
discussion_board_e	0.976	17.25	0.119	0.994	0.924	9.984	0.116	0.993	1.032	12.40	0.104	0.993
edit_homepage	1.113	9.351	0.065	0.989	0.936	7.504	0.079	0.983	0.991	122.0	0.168	0.991
electric_blackboard	1.126	8.196	0.061	0.992	0.842	5.266	0.072	0.950	0.982	5.154	0.072	0.980
messages_manager	0.978	245.4	0.128	0.985	17.769	5.192	0.008	0.925	1.052	3.689	0.073	0.923
personal_info	1.224	10.65	0.059	0.986	3.336	3.702	0.014	0.925	0.997	5.823	0.098	0.995
staff_information	1.084	4.877	0.048	0.982	0.992	4.321	0.044	0.967	1.049	6.430	0.080	0.989
student_roster	1.096	4.846	0.054	0.997	0.956	14.47	0.142	0.994	1.002	20.76	0.153	0.995

Following the methods used in Section 5.2.3 we will now apply the nonlinear regression method for the users' uses. In order to determine the Implementation Grade for the separate ActivityClasses we used the Gompertz curve. The Gompertz curve as presented holds 3 independent variables, which are 'a' for vertical movement or maximum value, 'b' for horizontal movement and 'c' for the slope's angle or the 'rate of change'. The dependent variable is the Lifespan in months. The Gompertz curve also holds exponential components based on the natural logarithm 'e'. SPSS supports nonlinear regression with a modelling instrument where independent variables can be user-generated. Using an iterative estimation algorithm SPSS was set to work to use the Gompertz curve to determine independent variables. To collect the variables, presented in Table 41, we used Script 13 again. As discussed in Section 5.3.3.3, it appeared that the Community and Course users only apply a few of the 23 distinguished ActivityClasses, however we calculated the variables for all of them, see Tables 41 and 43. The significant activities are presented in bold. They are set out in a cumulative way to follow growth over the Lifespan months. After that we took the maximum values of the last Lifespan month and then assumed those to be the virtually maximum implementation figures. This allowed us to normalise the Y-axis by dividing the monthly figures with their maxima.

Table 42: Overview Implementation Grade of Seat Time Activities from 10 to 90 Percent on Lifespan Axis

ActivityClass Percentages	C1		C2		C3		F1		F2		F3	
	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%
ab_add_contact												
check_grade	33	50					18	101				
collaboration												
course_tools_area	22	67	11	94	12	57	17	96	46	60	19	71
cp_academic_web_butt												
cp_add_group			8	40	13	35			19	93	27	51
cp_announcements			12	68	14	49			17	103	24	64
cp_collaboration												
cp_content			13	73	14	44			15	98	22	74
cp_digital_dropbox									28	121	21	100
cp_discussion_board	14	55	12	51	15	46	13	70	18	97	45	199
cp_gradebook			36	41					13	113	28	73
cp_send_email			13	53	17	51			18	121	20	67
cp_staff_information			10	79	3	63			11	108	19	82
cp_tasks												
discussion_board	17	40	14	36	17	46	13	90	25	111	26	125
discussion_board_entry	17	43	13	40	16	46	14	89	29	106	33	156
edit_homepage												
electric_blackboard												
messages_manager			102	x	7	49			17	98	50	231
personal_info												
staff_information	16	80	15	85	13	52	20	90	25	118	19	67
student_roster	14	71	13	35	15	35	19	78	31	87	22	72

In order to present the significant activities as graphs we looked at the 'critical mass' of their appearance. If we consider the first Lifespan month of Communities in Figure 45 and of Courses in Figure 47, we may set the critical mass from about 4 to 8 percent. According to Rogers the critical mass should be somewhere above 10 percent. We took save values from 10 percent to 90 percent of the implementation grade of the activities. These values for the significant activities are listed in Table 42 for Communities and Courses. The equivalent values in Lifespan months for the 10 percent and 90 percent data points present a fair way to determine the uses of the activities.

The sample data points of the significant ActivityClasses for student, faculty and staff are presented in Figure 71 for the Communities. The graphs were calculated using the Gompertz curve and based on the variables from Table 41. The Lifespan month range for the 10 to 90 percent values was taken from Table 42. We averaged the several activities per category for easier presentation. The Course oriented activities are drawn with dotted lines, the Community related activities are presented with continuing lines, the message oriented activities are presented with squares, presentation is denoted with triangles and finally tooling is presented using circles.

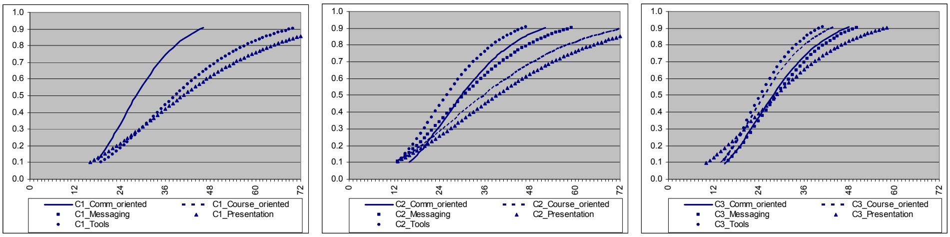


Figure 71: Implementation Grade of ActivityClasses based on Gompertz Curve for Communities

In the left students' graph the discussion board activities show a steep rise. This means that the discussions were significant from the start for students, although they only reached an implementation grade of 10 percent after 1.5 Lifespan years. After about 3 Lifespan years the students reached full use. The Tooling oriented activities rose with a flatter slope followed by presentation oriented activities. Such means that within the Communities in the later Lifespan years information about staff became commodity for students to search. Their full use was reached in about 6 Lifespan years.

For students discussions were significant from the start on.

In the middle faculty graph a similar development for the several curves is shown, however, for faculty the tools were important to start with followed by discussion board activities and messaging with a few months delay. The discussion board activities have similar growth values to those of the students. Content oriented activities lagged about a year in time, once faculty brought presentation online it directly was used by the students.

The right staff graph show more mixed growth for the several activities, starting with presentation but soon activities from all categories came into use. The staff use growth patterns fall in between of those of the students and faculty. It seems fair to argue that staff created the conditions for the students and faculty to pick up the several activities.

Staff created the comm's conditions for Students and Faculty to pick up the several activities.

We did a similar exercise for the Courses. The sample data points for the significant ActivityClasses for student, faculty and staff are presented in Figure 72. The graphs are calculated using the values of Table 43 and with Lifespan month ranges for the 10 to 90 percent values from Table 42. For easier presentation we averaged the several activities per category. The Course oriented activities are drawn with dotted lines, the Community related activities are presented with continuing lines, the message oriented activities are presented with squares, presentation is denoted with triangles and finally tooling is presented with circles.

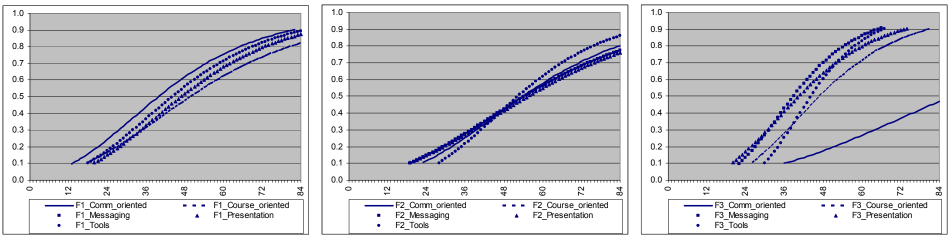


Figure 72: Implementation Grade of ActivityClasses based on Gompertz Curve for Courses

If we compare the slopes of Figure 72 with Figure 71 then it is obvious that Courses have a much slower Implementation Grade. According to Rogers new technologies have a longer road to go before they are excepted and adopted by their potential users (Rogers, 2003). When the online VLEs came on the market they only supported Courses. The Communities came in when the VLEs were 3 years in operation as Figure

42 from Section 5.2.1 shows. This maybe the reason why rates of growth are so much higher for the Communities, because the users were already used to work online in the VLE.

In the left graph of Figure 72 the discussion board activities are ahead on the course-based activities. It appeared that the students use the VLE as a communication platform right from the beginning. This is a striking observation because in the early years of the VLE only the courses were supported and brought online, but apparently the students saw the possibilities for online communication.

> *In the early VLE years, only courses were supported, still the students saw the possibility for online communication.*

The middle faculty graph shows similar growth but lagged by six months in time for all activities. Although tooling seems to have had a slower start it was easily adopted. The several activities grew simultaneously and were probably applied in combination to bring the subject matter online.

The right staff graph shows that all activities but discussion board were applied simultaneously as for faculty. The steeper slopes for higher rates of growth of content oriented activities are striking. The Community oriented activities were clearly used in later years at a much lower growth rate. It looks as if staff prepared the VLE for content oriented uses while students pushed the communication oriented activities and faculty dealt with both uses.

The variables of the Gompertz curve are listed in Table 43 for student, faculty and staff. The figures in bold are the same as the variables selected in Section 5.3.3.3.

Table 43: Estimates of Curve Fitting for Users' Uses of Courses

UserClass	Student				Faculty				Staff			
ActivityClass	**a**	**b**	**c**	**R^2**	**a**	**b**	**c**	**R^2**	**a**	**b**	**c**	**R^2**
ab_add_contact	1.154	6.132	0.051	0.991	1.246	8.990	0.053	0.974	0.982	9.038	0.077	0.987
check_grade	1.297	4.356	0.037	0.981	1.009	8176	0.402	0.997	1.322	5.231	0.039	0.972
collaboration	1.469	3.260	0.027	0.983	2.213	4.716	0.025	0.948	1.171	4.989	0.044	0.994
course_tools_area	1.255	4.433	0.039	0.992	1.015	7424	0.226	0.968	1.064	7.124	0.060	0.994
cp_academic_web_b	1.439	6.223	0.038	0.985	1.241	5.663	0.047	0.980	0.997	4.980	0.058	0.949
cp_add_group	1.545	5.576	0.035	0.991	1.258	5.131	0.042	0.990	1.010	67.03	0.128	0.985
cp_announcements	1.280	4.483	0.040	0.994	1.334	4.212	0.036	0.996	1.005	13.92	0.077	0.989
cp_collaboration	1.416	2.500	0.026	0.962	1.256	2.523	0.032	0.949	2.541	4.920	0.022	0.993
cp_content	1.172	4.877	0.046	0.994	1.262	3.915	0.037	0.993	1.040	8.570	0.060	0.990
cp_digital_dropbox	1.138	3.499	0.043	0.992	1.598	5.692	0.033	0.991	1.240	5.028	0.039	0.994
cp_discussion_board	1.068	4.573	0.054	0.986	1.276	4.618	0.039	0.978	3.626	5.679	0.020	0.995
cp_gradebook	1.364	4.025	0.035	0.987	1.411	3.398	0.031	0.972	0.956	15.25	0.069	0.973
cp_send_email	1.289	4.538	0.039	0.992	1.545	4.359	0.031	0.993	1.023	8.819	0.067	0.991
cp_staff_information	1.358	4.950	0.039	0.990	1.319	3.252	0.032	0.991	1.116	5.839	0.049	0.994
cp_tasks	1.446	4.442	0.033	0.984	1.176	4.115	0.044	0.982	1.045	4.775	0.052	0.986
discussion_board	1.177	3.809	0.040	0.989	1.524	5.659	0.036	0.977	1.591	5.052	0.031	0.993
discussion_board_e	1.197	4.068	0.041	0.991	1.506	7.101	0.040	0.964	2.186	5.209	0.025	0.992
edit_homepage	1.107	6.597	0.056	0.988	1.182	30.92	0.074	0.951	1.125	6.986	0.053	0.993
electric_blackboard	1.244	4.724	0.042	0.989	1.046	1347	0.151	0.957	1.035	8.872	0.064	0.993
messages_manager	1.063	14.861	0.077	0.978	1.333	4.363	0.038	0.954	4.470	5.341	0.017	0.985
personal_info	1.244	4.879	0.042	0.990	1.680	5.089	0.032	0.956	1.032	4.872	0.058	0.996
staff_information	1.208	5.437	0.044	0.994	1.650	5.148	0.033	0.978	1.034	8.290	0.066	0.991
student_roster	1.134	5.917	0.052	0.989	1.269	12.50	0.055	0.989	1.076	9.053	0.062	0.991

5.4.6 Conclusion of Users' Uses

If we refer to question c "Can educational technology in operation show us appropriation and structuration processes?", posed in Section 2.3, we can answer affirmatively.

DeSanctis and Poole argue that the use of technology creates its own social behaviour within organisations through its uses. They approach such changes in behaviour from two perspectives, the types of structures provided by the technology and the structures that actually emerge through human interaction (DeSanctis & Poole, 1994). If we think of structures then we can take the community and the course structures as two types provided by Blackboard VLEs. For human interaction we focussed on the users' uses from out of the Community perspective and from the Course perspective using messaging, presentation and tooling. For the users' uses we investigated empirical data from 171 higher education institutes to search for patterns.

Students' uses remain the same over the years despite the annual addition of first-year students.

The structuration process, as DeSanctis and Poole call it, is the evolutionary character of groups or organisations when they interact with technology. When we look at our findings we can see that the behaviour of students over the Lifespan axis did not change, for the 6 Lifespan years of Communities and for the 7 Lifespan years of Courses the students' behaviour remained the same even with the annual addition of first-year students or maybe just because of it. Faculty and staff did change their uses over the Lifespan years. The Community instructors started with long hours sessions in the first 2 years where typical communication activities were added to the VLE, other activities followed over the years. The Course instructors started with very long sessions in the first year only, they were adding content and messaging. Meanwhile the Course oriented activities were expanded with presentation while tooling took the lead over the Lifespan years. Course staff only started using discussion board activities after several years.

Faculty and Staff started with long sessions in the first two years.

The appropriation process, as DeSanctis and Poole call it, is the dynamic usage of the technology for ones own purpose. When we consider the findings of our DUT case then we may conclude that faculty and staff use the VLE's functionalities for effective one-to-many messaging and for efficient distribution of educational subject matter. This conclusion is strengthened by a recent study (Tempelman, 2009). If we consider the empirical data of all higher education institutes then we may conclude that over the Lifespan years online Communities and online Courses have come into existence. The Communities show changes from communication focussed activities to content-based activities while the Courses show a focus change from purely content-oriented activities to a mixed setting with communication-oriented features.

In our way to confront hypothesis 2 with our findings we are confident in saying that the VLE's activities follow S-shaped curves. Moreover, content oriented activities and community-oriented activities seem to appear in some sort of consecutive orders dependent on Community or Course. However, we were only able to present a few basic ActivityClasses for Communities and Courses that had enough spread in Lifespan months to bring forth conclusive evidence for hypothesis 2. We obtained evidence for consecutive growth patterns of Course oriented, Community oriented, messaging, presentation and tooling activities.
If more logging data are collected in the coming years for ActivityClasses that carry other pedagogical practices, such as online tests, online collaborative work, peer reviewing, and professional blogging, then the second hypothesis could be tested deeper. For now, we rest with the knowledge that the evidence might be not robust enough for the complete Lifespan years of the VLE, however, the hypothesis is certainly valid for the first seven Lifespan years. We end this section with a statement that corroborates with the second hypothesis of Section 2.5.2.

The uses of the VLE functionalities follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve

5.5 Answering Research Sub Question B

In Chapters 4 and 5 we investigated the implementation of the Blackboard VLE. Implementation as such was discerned as the 3rd main literature stream (see Section 1.3.3). We focussed on empirical data to give meaning to the implementation process. Hence, we collected equivalent but censored datasets from 289 institutes. The datasets were imported into a research base and classified in 6 classes as presented in Figure 29, Chapter 4. The classes are ScienceClass, CourseClass, InstituteClass, ServiceClass, UserClass and ActivityCLass. Once the data was cleansed and available we analysed the empirical data descriptively and with tests to find evidence for hypothesis 1 aimed at the system's uses and for hypothesis 2 aimed at the users' uses.

The database structure of the Blackboard VLE from our DUT Case was explored in Chapter 4 and its logging data arranged to express the system's uses in numbers, hence, we introduced some indicators, which we structurally followed when exploring the datasets of all 289 collected cases. In the first descriptive analysis part of Chapter 5 we studied the distributions for the several indicators of the 4 InstituteClasses corporations (Corp), further education (FE), higher education (HE) and K-12 (K12), and for the 2 ServiceClasses communities (C) and courses (F). However, only the results for higher education were presented because of their direct relationship with our study. It appeared that only 2 percent of the collected data held communities and there was only enough data for higher education to allow a robust analysis of the communities.
We also explored the users, for our study we focussed on the users student, faculty and staff. Faculty and staff were designated instructor. The number of educational handlings of the student versus instructor was striking, for every student an instructor did 0.69 times the number of actions to keep the community going. Based on a 1 to 1 communication pattern for communities such is only feasible for small communities, however, the instructor did 0.28 times the actions of the students to keep the courses going. This can be explained, bringing subject matter online takes a lot of effort, but once online the distribution of it is arranged and efficiency and ease-of-use start to bring in benefits. The automatically generated communities and courses were also striking because more than 40 percent of them had lifespans of zero months.

In order to test hypothesis 1 we explored 238 CourseClasses and ordered them into 5 ScienceClasses. These were transposed from calendar time to a normalised Lifespan X-axis and a normalised Implementation Grade on the Y-axis. Following two parallel tracks for the subsets Communities and Courses we determined growth patterns using a nonlinear regression model based on the Gompertz curve. This allowed us to catch the implementation grade of the Blackboard VLE in a reliable model and to validate the first hypothesis.

Higher Education VLE implementation grows along an S-shaped curve following the model a * Exp(-b * Exp(-c * Lifespan)) …

… with Lifespan in months, with the variable 'a' as maximum number of courses of an institute, the variable 'b' as a horizontal shifter with value 3.2 ± 0.2, and the variable 'c' as 'rate of growth' with value 0.37 ± 0.1. The mean Lifespan of the VLE is 19.26 years with a standard deviation of 3.73 years.

Next, we introduced indicators for the users' uses, caught under seat time activities. We followed these structurally to explore the 171 higher education institutes that held educational activities. We found that many communities and courses had no educational activity. These were generated automatically at the beginning of a new academic year. About 80 percent of the communities held seat time activities and only about 45 percent of the courses held them. The low percentage for Courses can be explained by the logging of educational handles that only became available 3 years after the VLE came on the market. We analysed the seat time activities for 6 subsets: student, faculty and staff, for both Communities and Courses.

We found that work periods of 8 hours for student, faculty and staff are common, however, the work periods are spread over 24 hours of the day. Thus the Blackboard VLE is always occupied. All the VLE users started with zapping behaviour in the first minutes after logging-on to check multiple communities or courses. Shorter and longer sessions were quite proportionally distributed for all of the users, both for duration and for moment of the day. It is striking that only a few ActivityClasses are popular, this in the end determines the type of usage for the VLE.

We transposed the seat time activities from calendar time to a normalised Lifespan X-axis in months to test for the second hypothesis. The students had no observable change in behaviour, neither in duration nor in their seat time moment, however, their activities clearly showed community-oriented activities from the start. When more information and content came online they directly made use of it. Faculty and staff did change their focus of activities over the years. The communities started with discussion board activities and over the years course activities came in. Once the instructors brought in new materials and information, the students took advantage of it. Something similar occurred for the courses, the students started with community-oriented activities while the staff were busy with messaging and bringing in professional presentations for personal and course information. Faculty made use of the combined students' community actions and of the staff course activities expanding the uses of the Blackboard VLE. However, it took years before staff took up the community-oriented activities.

The implementation of the several activities grew along S-shaped curves and the community and course oriented activities followed more or less successively over the Lifespan. This allowed us to catch the implementation grade of the seat time activities with reliable figures. We can confidently state that the second hypothesis is valid, however, only for the first seven Lifespan years of the Blackboard VLE. No more data was available.

The uses of the VLE functionalities follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve.

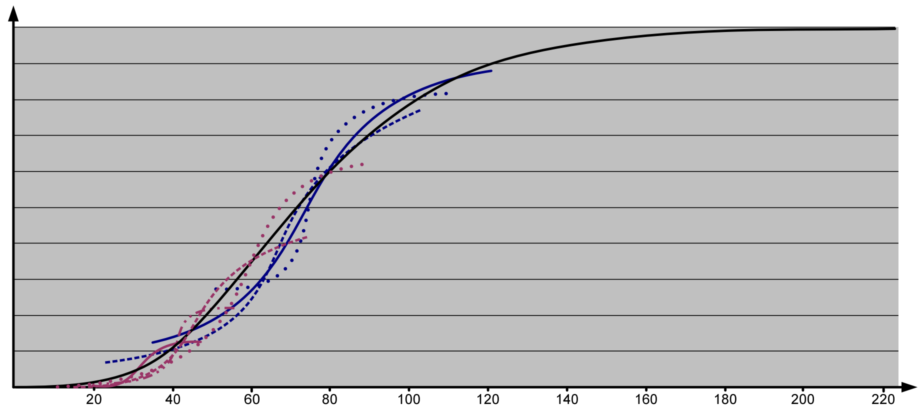


Figure 73: Big Picture and Small Picture integrated by A.H.W. van der Zanden

The S-Shaped curve of the VLE is represented in black in Figure 73. The Lifespan S-shaped curve of about 2 decades is projected on the timeline. The users' uses are represented by the minor and successive S-shaped curves of the applications of the VLE. The purple S-shaped curves representing the Comm-oriented and messasing activities raised quick after they were made available for use. At first the comm-oriented activities were used, presentation followed. Course oriented activities, however, were carried out in a slower rate after the community oriented activities had been common use. Presentation followed even more slowly. The blue curves, representing the activities from the Courses, took longer to be adopted since the VLE was introduced. The course-oriented activities were followed by comm-oriented activities. Tooling, messaging and presentation were activities that only later were used to support the courses.

6 CONFRONTING LITERATURE AND EMPIRICAL DATA

Rationality did not appear to be helping much. I turned to emotion,
and began, shrinking from the task, to reconstruct the details …

Well, if not reason nor emotion, what of duty? …
I would have to rely on something else; just what, I wasn't sure.

From Outlander
by Diane Gabaldon (Gabaldon, 1991)

We have studied literature and we have studied the VLE system's growth and uses. When we compared literature with the collected evidence, we have come to insights that were composed into statements given in this chapter. These statements are explained and give thought to work out additional ideas or successive developments.

6.1 VLE IS LEVER FOR COLLABORATIVE LEARNING BUT NOT THE APPROPRIATE TOOL

Referring to question 0 "If modern technology has led to new pedagogies within higher education", posed in Section 3.2.7, we cannot answer conclusively, however, …

The virtual learning environment (VLE) began to be used extensively in higher education practice after two decades of computer based training (CBT) in the late 1990's and early 2000s, see Section 3.4. Web-based course management was a welcome online tool that could be used to present learning materials at a centralised website. The Blackboard VLE used for our case study, also has administrative tools to automate related processes, such as staff information, exchange tools, grade book and quizzes. Efficiency and ease-of-use are the driving forces for teachers to use a VLE, see Section 4.2. A very important additional feature is the online communication facilities VLEs provide for centralised one-to-all email messaging and one-to-one discussion board facilities, as the empirical findings have shown us.

Use of a VLE allows teachers to address both communities and courses for higher education. The VLE seems to have fostered collaborative pedagogies, with online communication at the heart of group work. It has been used to build a bridge between instructional pedagogies and online group work. The VLE has supported the firm growth of communication activities over the years, this is logical because online communication has become an important feature, used by those involved with higher education to streamline and visualise communicative interactions between people. With such interactions stored on a VLE system and available for reference, others can learn from such discussions without being there, this is a tremendous advantage for sharing knowledge. This type of communication storage has been influenced by several social software movements which have dominated electronic communication in higher education since their introduction. These social software movements have positively influenced communication features used within the VLE.
However, as indicated in Section 5.1.5, we doubt whether a VLE is the correct type of system to support online communication in higher education. Probably not, because efficiency and ease of use are important for teachers as we learned from our qualitative study and discussion in Section 4.2. It appeared that instructors have to execute 0.69 times the number of students' actions. Such number is doable for discussions with smaller groups of participating students, but for larger groups and more discussions, the teacher will soon reach his or her limits.

Another striking element is that the VLE has been used in ways that were not foreseen. Initially, we assumed that any course could only have one or two instructors, but after a more detailed study, it appeared that sometimes courses were set up for professional communities, with every member able to be an instructor or community leader. These groups use functionalities of the VLE for their professional peer group activities. In such communities, every member is allowed to edit the stored learning objects shared amongst them. Such 'community of practice' uses can be compared to provide collaborative design features. We were also surprised to see that the VLE system we observed was regularly set to work for informal purposes considering the great amount of guest users for communities. Again, the Blackboard VLE has been used to build a bridge, this time it has fostered communities to communicate even beyond the strict networks of students and teachers.

We do not have figures of VLE uses outside the Blackboard VLE and can only presume that the increase in use of social software as add-on technology within higher education is filling a need that the Blackboard VLE supports poorly. Social software and its underlying repositories are expected to be the next educational technologies, as indicated in Section 3.4.4, hence, the Blackboard VLE has played a most important role in levering higher education in its striving to modernise and innovate its pedagogies. We might suggest that the Blackboard VLE has supported the movement of using new pedagogies in higher education although the product itself did not aim at innovative pedagogical approaches upfront. Blackboard helped teachers to take a first step into using new technologies for teaching purposes. For reasons of efficiency and ease-of-use, they have adopted technologies that might end up becoming a pedagogical Trojan horse for the education establishment.

6.2 Growth of VLEs in Higher Education matches Product Innovation Theories

Referring to question b "if the S-shaped curve, as product forecasting approach, can be used to catch the growth of educational technology in operation", posed in Section 2.2, we can answer affirmatively …

When we compared the logging data from our 289 collected VLEs, we found that the data were not normally distributed. An obvious indicator for non-normally distribution is when the mean values are too deviated from median values. Other normal distribution checks corroborated with this observation, but applying curve-fitting strategies showed that the logging data followed growth patterns, such as Richard Nolan (Nolan et al., 1992) and Carlota Perez (Perez, 2002) propose for IT growth, see Sub-section 2.4.2 for a discussion of Nolan's stages theory for IT in corporations where growth is seen to form S-shaped curves. In order to catch the VLEs' growth in a model we used the Gompertz formula, discussed in Section 2.2, using the CourseClass category to determine growth, we found sound evidence for the proposed growth patterns.

Several classes for the collected data were introduced in Section 4.5. When we categorised 238 Course Classes under their 5 science classes for communities and courses fine growth patterns following S-shaped curves were found. The R-squared values, presented in Section 5.2.3, indicate reliable figures and give evidence for the innovation theory with R-squared figures of 98.7 percent for communities and 99.7 percent for courses.
As product forecasting is a common practice in the corporate sector, why should we not use it to forecast successive educational technologies now we know that the patterns match. We realise that future descriptions of social systems, such as higher education is, are commonly based on scenario planning methods (Bell et al., 2004; Boezerooy et al., 2008; Collis & Gommer, 2001; OECD, 2001), but why not step out of the standing paradigm, as discussed in Section 3.2.2, and grasp the future educational practices with technology as our guide.

6.3 Critical Mass is Tangible for Educational Management

Referring to question d "if the critical mass can be caught for the implementation of VLEs", posed in Section 2.4.1, we can give an affirmative answer as well.

The Gompertz formula holds multiple variables but the one holding the rate-of-change is important for educational managers. It appears that the institute may influence a lead or lag of 3 to 4 years, as compared to an averaged lifespan of 19 years. We found evidence that the use of a VLE as an educational system follows calculated product curves and their use opens the way for other educational technologies to be adopted. Thus such tools can be used by educational managers to manipulate their university's position with respect to prominence and to attract students (Mohrman et al., 2008).

Bringing a university into a leading position in education might make the difference between attracting more students or obtaining additional funding and failing in the arena. Our qualitative study in Section 4.2 taught us that one should keep the focus on efficiency and ease-of-use for faculty and staff when introducing new educational technologies within daily practices. Although we learned from Chapter 3 that technology use accounts for only a part of the social system that a university is, technology still offers great opportunities for proper policymaking. Moreover, knowing the periods for pilot projects to reach sufficient critical mass to implement modern technologies do help educational management. We will elaborate in Chapter 8 on developments that influence the university and add to policymaking.

6.4 VLE's Lifespan within Higher Education is 15 to 23 Years

Referring to question f "if the VLE's growth can be caught in rate-of-change and lifespan parameters ", posed in Section 2.4.2, we can give affirmative answers as well.

We can take the lifespan of VLE use as indicator that can be put forward when designing new strategies for educational management. From our study we derived a VLE's lifespan to be about 15 to 23 years. This implies that within a decade from now the primary education process will use another educational technology if we consider the starting year 1999 of our DUT case. In Section 3.4.4 we described how this successive educational technology is expected to consist of portals and repositories on which new pedagogies will be built. Considering the evidence and innovation theories we are aware that the implementation of new technologies within education take long times to thrive.
We know from literature also that learning-on-demand will be fully functioning within a few years time (Altbach et al., 2009; Brown & Duguid, 1996; Collis & Moonen, 2002; Commissie Europese Gemeenschappen, 2000; Iiyoshi & Kumar, 2008) and we discussed in Section 3.4.6 the portal and repository technology that has begun to be introduced into higher education on an experimental base, hence we are confident in saying that the use of portals and repositories is inevitable, and can be expected to be used in higher education within a decade. Knowing this, educational management can focus on mission-making for the coming competition in higher education. See Chapter 7 for a description of successive educational technologies and its practices.

6.5 Diffusion of Adopter Categories could not be demonstrated

Referring to question e "if the VLE's diffusion can be caught in Rogers' adopter categories", posed in Section 2.4.1, we were not able to answer conclusively. We lacked sufficient data available to give a plausible answer. However, …

Diffusion is the process in which an innovation is disseminated through time among the members of a social system. We interpreted this diffusion aiming at the VLE and looked at local diffusion and users with their uses, and would be interested at how diffusion took place within the (inter)national geographic system. Knowing now that the growth of VLE's follows Nolan's corporate theory, we expected that use of VLE's diffusion would follow the theoretical figures for Rogers' adopter categories, as was presented in Section 5.2.4.
We could have checked the two diffusion patterns if we had known the maximum population from the collected institutes, and their addresses. However, we lacked both figures for reasons of anonymity and privacy. What we did have were figures from our Test Case, but that was only one case. Based on the qualitative study we collected figures, which indicated that 93 percent of the instructors questioned used the Blackboard VLE. From the quantitative figures, it appeared that we should be able to get an indication of matching figures; however, a sample growth of one is too small to be generic, hence, we could not demonstrate the diffusion figures for our collected data in a valid way.

6.6 Appropriation of the VLE could be demonstrated, Structuration could not

Referring to question c "if educational technology in operation can show us appropration and structuration processes", posed in Section 2.3, we were confident to answer affirmative, but for the first seven years of use only.

The results of our empirical study showed that the VLE uses also followed S-shaped curves. We could therefore apply the Gompertz formula with even such high R-squared values, however, the slopes of the several activities were divers and multiple S-shaped curves crossed each other. Such crossing means that the uses of the one seat time activity grew faster than another. In other words, the focus of the seat time activities changed over time. Such changes over time are very interesting, since these corroborate with the second hypothesis, and may be visualised using successive S-shaped curves. Of course, we have only demonstrated this for use of the Blackboard VLE. Still we argue that the same will count for other VLE's, because all VLE systems are based on similar IT architectures.

The adaptive structuration theory, described in Section 2.3, deals with such change of uses of technology. It appeared that appropriation as one part of the theory did its deal. Appropriation is the adoption of a certain technology to fulfil daily work actions with the help of such technology. Innovators and early adopters were the first to use activities that delivered efficiency and ease-of-use. As these early activities became routine successive activities began to be carried out using additional functionalities.

The structuration process as another part of the AST theory deals with social behaviour, which is much harder to demonstrate. Organisations should come into existence when people are working together and where technology is used to help them by enhancing ways of work. We found some fine examples in our test case where communities of practice were set up to give all members the same read, write and modification rights to create peer groups. However, we did not have proper data within the collected datasets to show such appropriation processes, thus no plausible conclusions could be drawn.

6.7 The VLE is being used for over 18 Hours of the Day

Referring to question l "if students and instructors of today's educational technology show signs of uses that typically belong to such technologies", posed in Section 2.3, we were positive.

It is common practice in higher education to plan lectures during office hours to give a normal study and working week. Our empirical data showed that working days still consisted of eight working hours. However, the working day seemed to be broken into smaller parts of working hours, even fragments mended into a few minutes. Students especially divided their online working attitude over about 18 hours of the day, which indicated that their uses of the technology were tuned to their needs. The figures showed an occupied VLE from seven o' clock in the morning up to eleven o' clock in the evening. Faculty tended to divide their working hours over 12 hours in shifts while staff mainly worked during regular office hours, see Section 5.3.2.

Our analysis of the use of the Blackboard VLE showed that shorter and longer sessions were equally distributed over the day. It is not clear why we found such similar distribution of activities. One possibility may be that, due to globalisation faculty members work at other locations on the globe. Another possibility is that students may fit their activities around jobs to gain (extra) income, hence the students may spread their learning activities over the day. The result is that education institutions are obliged to keep their VLE system up and running round the clock. The VLE has become a critical business process within higher education. Fact is that students and instructors take the opportunity to flexiblise their time schedules.

6.8 Uses of Instructors have been changing, Student's Uses have not

Referring to question r "if Internet literacies, supposed to be related to online learning, can be recognised in the VLE uses", posed in Section 3.5.4, we have seen changes in the uses of instructors, but not in those of the students.

When we studied the VLE's uses, it was striking that students' uses did not change over time. The new student and shifting to the next academic year did not alter student uses of the system over the 7 years of logged data. It shows that different students over the years had similar uses for the seat time duration, see Section 5.4.2, and for seat time moment and seat time activities, see Sections 5.4.3 and 5.4.4. An explanation of this stable student behaviour might be that students already possess a working attitude for handling online technologies when they enter higher education. In other words, they are already literate with online working.

Faculty and staff changed their uses of the VLE over the years. In the early years, the seat time duration showed long working days with very long sessions. The staff were probably uploading their subject matter and other learning materials to prepare courses for online distribution alongside periodic messages. After two years, they fell back to regular office working hours. The seat time activities showed the changes the best, see Section 5.4.5 for the figures that illustrate that course activities were added over time when working in communities and how community activities were added over time in courses.

We know that course materials had to be put online in the early years of the VLE. However, if we think about successive educational technologies such as portals and repositories, with which students probably are being considered as knowledge producers, would it be possible that the uses of instructors and students will converge?

6.9 Zapping is Normal Behaviour for Online Users

Again referring to question l "if students and instructors of today's educational technology show signs of uses that typically belong to such technologies", posed in Section 2.3, we have seen such typical zapping behaviour in the first minutes for all of its users.

Checking if there is news for me, checking if there are changes in issues that concern me, checking if others have left me a message, an assignment, a need-to-know, or nice-to-know. These are the very first activities that a user does when coming online or logging on. We found that VLE users did a massive number of activities in the first fifteen minutes of their online connection, see Subsection 5.3.1.3. The VLE users triggered multiple functionalities to keep pace with their communities and courses. Although we only had 7 years of data for the VLE's lifespan, we think it is plausible that such explorative checking will remain a common behaviour.

In the information age where scarcity of information, of communication, and of presence have begun to disappear, see Sections 3.1.4 and 3.3.5, the online worker is triggered by incoming messages and changing news, and such checking in the first minutes of starting to work online appears to be a typical start activity for networking. You must be up-to-date to pick up your work where you left it when you logged out. In earlier times, news came from mass-media such as television, radio and newspaper. At the workplace, news was disseminated by line-management or local bulletins. The worker knew his duty for the day in the industrialisation era, but today news is presented just-in-time and just-for-you. Today the worker is triggered by his or her surroundings, he or she orientates on incoming news from his or her human network, from his or her online network, from his or her relevant resources, from news generators and even from unwanted information-pushes. The networker clicks from information channel to collaborative network to start the working day informed and effective. He or she checks them all, hence zapping behaviour has become common behaviour for online users (Veen & Vrakking, 2006), meaning that structuration is truly taking its place next to appropriation.

6.10 Uses of Educational Technologies shape the Way of Work of its Users

Another time referring to question l, we are convinced that that users adapt their way of work to their working environment.

The instructors of the VLE adapted their ways of work over the years. Consequently, we can imagine how people might use new technologies within their organisation. When we focus on successive educational technologies, we must be able to make a good guess as to what will be the corresponding educational practices. We will do that in Chapter 7.

As an example of how artefacts do shape educational practices, we want to discuss the lecture room, for instance, the amphitheatre with its tiers of seats that force the teacher to use frontal instruction pedagogies. This works fine for teacher-led instruction, but group work cannot be facilitated in such theatres. As a result, many single-levelled lecture rooms with movable furniture has become a standardised layout in many universities in the last century. These lecture rooms allow collaborative pedagogies to be used, for instance placing the tables and seats opposite, so that the students are facing, facilitates discussion and group work.
Based on such thoughts a number of institutes have been experimenting with learning centres (Oblinger, 2006) where new architecture, flexible furniture and state-of-the-art technologies are used to facilitate innovative pedagogies with online and offline communication as an important condition. George Siemens with his idea of Connectivism, see Section 3.5.6, claims the same sort of arguments when using modern technologies (Siemens, 2005). Higher education institutes are constantly seeking ways to push artefacts forward to facilitate new pedagogies. Hence, we remember Winston Churchill's famous words "We shape our buildings, and afterwards our buildings shape us" (1943) implying that when a building with certain functionalities and typical characteristics is used and occupied by people, then people will begin to suit their work practices to the building environment. John Culkin followed Churchill's words with "we shape our tools and thereafter they shape us" (1967).

6.11 CONCLUSION

We considered insights derived from our investigation in this chapter. The collected data and related literature studied served as input for the above-mentioned propositions.

Teachers have been faced with increasing student numbers over the last decades resulting in a need to instruct more students at the same pace at the same place. Meanwhile, one-to-many instruction has replaced the former master-apprentice approach. Technology has come on the market that can be used to help the teachers deal with the consequences of these developments for managing their teaching duties. Hence, it is understandable that teachers started using the Blackboard VLE for efficiency reasons. Over time, technology has offered possibilities to add new forms of pedagogies, efficiency and ease-of-use make technology attractive to teachers and students.

Higher education has been faced with the virtual learning environment as an institutional infrastructure. The Blackboard VLE has been in use for a decade within many higher education institutes and it has become business critical. Literature has shown that many new technologies, such as social software applications, online games and mobile tools, have been brought into the classroom, however, most uses were pilot projects with limited terms, and these uses of new technologies has not lasted. It seems logical that use of these new technologies stopped or diminished, because they have to fit within the long-term institutional infrastructure of the VLE. Many supporting processes of the organisation have been adjusted to this long-term infrastructure, hence, non-fitting tools will not survive in this environment.
Only when the next generation educational technology, literature and corporations move towards the use of portals and repositories, and this is institutionalised as successive infrastructure for the higher education organisations, then modern tools will gain their place. Considering our figures this will take another 5 to 10 years before a critical mass with an implementation grade of at least 10 percent is reached.

7 SUCCESSIVE EDUCATIONAL TECHNOLOGIES

Now let us see how this principle of great benefit being derived from divergence of character, combined with the principles of natural selection and of extinction, will tend to act.

From On the Origin of Species by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life by Charles Darwin (1859)

In this chapter we discuss successive educational technologies and their benefits. We consider current and new developments in the field, and set a direction for the future of technology in education. We will discuss a number of connected micro-trends that are expected to have an influence in the coming decades, and elaborate on the next era of information technology. We answer research sub question C: "*What is the new educational technology that will be used in universities?*"

7.1 VANISHING SCARCITIES

Educational technology has been and still is reducing scarcity of information for all. Information has become ubiquitous, easily accessible, and most of the time even for free. This revolutionary change in access to information has also brought an overload of information (Hijazi, 2004; Kirsh, 2001), to dwelling and losing track when looking for answers on the Internet. Internet browsers let users do as expected; they browse, but from time to time fears about information overload lead employers, teachers and parents, to warn employees, students and kids, that using Internet costs money or does not give you any guarantee of trustworthiness. However, employers, teachers and parents themselves have often poor understanding about evaluation techniques of Internet resources, knowledge sharing and participative approaches of knowledge creation. They loose track and are attracted to browse for irrelevant information.

Why do we not ignore such messages and turn statements around? Could we not better talk about an inverse system of information? Not about the formalised, hard to reach publish process of registered publishers culminating in books and publications, but about free speech, free art, or other free expression culminating in public creations of free artefacts available for anyone, anywhere on the Internet. Given the unrestrained availability of information, we would like to talk about disappearing scarcities.

Books were scarce resources in the beginning of higher education, only available to the rich. The advent of the printing press has increased immensely the multiplication of books on the sciences, arts and religion. Books became richly available for the middleclass people in the last century. Today, public information centres, national and local libraries, are readily available in developed countries. We may conclude that the ***'scarcity of books'*** has vanished.
If we consider the overload of information set out in books in the last century, we will not complain about the overabundance of these books: rather we will focus on the opportunities brought about because of books. Analphabetism was firmly fought in response to the availability of so many wonderful books. This and the changing need for a, at least primary educated work force, led to compulsory education and standardised educational systems for everyone, in developed countries, nations profited from the technologies of those days.

7.1.1 Free Information demands Information Skills

Ever increasing numbers of electronic information resources are coming online on the Internet, both formal and informal. The formal information consists mainly of information or advertisements from governments, corporate institutes, newspapers, shops and all sorts of professional communities. Informal information is derived from people who want to share hobbies, opinions, ideas, protests and many other messages. Meanwhile institutes and libraries are working hard to bring validated information resources to the public as a counter movement for the inverse and sometimes inferior information, of poor quality, presented on the Internet. Libraries are organising courses to train people in information skills, in search strategies and validation assessment techniques. Those typical information skills are no longer the preserved of librarians, they are essential for general literacy when someone uses the Internet.
What has changed is that everyone is able to access information. Consequently, in addition to books, the Internet on its turn is reducing the ***'scarcity of information'***.

Consequences of the ongoing reduction of scarcity of information are tremendous: it is going to change the ways to communicate privately and professionally, using new tools; it is going to change structures of organisations, flattening hierarchies and creating new procedures and business models (Veen, 2009); it is also changing the relation between government and citizens, making political parties obsolete in times of a participatory culture (Castells, 1996, 1997a, 1997b). Just as the printing press changed social structures of societies, the Internet is going to change current societal, economic, organisational and political structures.

7.1.2 Online Interaction demands Communication Skills

When the PC came to market in the 1980s, courses were offered for office workers and computer-based training programmes were set up for stand-alone learners. Over time, networks interconnected PCs and email became available to all ICT users. Around the millennium, when VLEs were introduced, they were initially aimed at teacher-oriented objectives such as management of learning materials. These first generation VLE's were substituting old teaching practices, only to integrate new practices built on online communication features and aiming at collaboration after a decade or more.

Very important were the developments in society, where online communication has grown tremendously using mobile phones as the main facilitator of such communication. Today, we may say that electronic devices can be used to connect everyone in industrialised countries, no matter what electronic device, connecting will be one of its features. As a result, we may say that we are living in an era where the ***'scarcity of communication'*** is about to diminish to unknown low levels.

7.1.3 Online Connectedness demands People's Status

When people connect to the network, they are online and available for interaction or contact. Once online, formal and informal communications become mixed and intermingled. For instance, children can call their parents to get an answer to a simple question while they are in an important meeting at work. The communication industries have introduced status parameters into their communication software to deal with such uneasy situations. Unified-communications is aimed at regulating a person's communication channels (Kim et al., 2008). Communication software can be used to show the presence of people, whether a person is available to receive messages or calls, whether they are busy in a meeting, making a telephone call, away from their desk but back in at a certain time, or just not available. The presence of people is visualised and presented using such technology, leading to the disappearance of uncertainty when one wants to make contact.

We are heading for an era where everyone is traceable and reachable. It seems normal that people are connected, however, one must input status data about one's accessibility, about one's approachability. Otherwise, differences between formal and informal communications will be completely blurred giving rise sometimes to uneasy situations. Consequently, we may say that presence is replacing absence meaning a decrease in ***'scarcity of presence'***.

7.1.4 Free Learning Materials demands Reposition of Universities

Online publication of research articles and conference proceedings is common today. However, publishers retain their strongholds because one has to pay for these publications, although the research to produce them was initially funded with public money. Counter movements are underway, with researchers putting their work online through other peer processes and public discussions. In the Netherlands, the Ministry of Education, Culture and Science is discussing the idea that research results funded by the government should be freely published and accessible for the public (Oosterbaan, 2009).

Educational movements have emerged that publish learning materials for free. It started with the share and exchange of content through databases and repositories, with initiatives such as www.merlot.org, www.ariadne-cms.org, www.openlearn.ac.uk, and many more, followed by the OpenCourseWare initiative with MIT as its front-runner. Multiple institutions have organised their processes to produce and share open educational resources (OER). These are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others, but not necessarily commercial use. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software and any other tools, materials, or techniques used to support access to knowledge (Atkins et al., 2007; Groot-Kormelink et al., 2009; Gurall, 2008; Iiyoshi & Kumar, 2008).

Having and teaching valid subject matter has been the core business of universities for centuries. Today such learning material end products are paralleled with creation and validation processes designed to help teachers produce such end products. The interaction between mono-disciplines and multi-disciplines for co-creation and collaboration to produce learning materials will be the new core business processes for universities (Gibbons et al., 1994; Mohrman et al., 2008). The making of OER in many disciplines will mean that, in due time, valid learning materials of all sorts will be displayed and demonstrated on OER *shelves*.

Tomorrow's students and life-long-learners will be able to pick out the learning materials that fit with his or her major or master track and the problem they wish to solve. This process, which we like to call a *Learning mall*, might well become a common future educational practice. At the least, the '*learning mall*' seems to be one obvious outcome of today's emerging technologies.

The *learning mall* with its high-quality free learning materials is an ideal knowledge market for people in need or in greed, especially those geographical areas kept away from learning materials, such as isolated countries, regions after natural disasters, developing countries, and other places where hard copies can not be found in stock. The ***'scarcity of knowledge'*** is bound to reduce considerably, and as a result, universities will have to reposition their market value (Bradwell, 2009; Gibbons et al., 1994; Melville, 2009).

7.1.5 Concluding Remarks

Information Technology, active in the science domain since the 1960s, has started to spread as a support technology. Today, it is used in businesses to automate repetitive tasks, it supports communication channels, and tomorrow it will be used for tasks were intelligence is required to search and select data interchangeably for man and machine.

The overabundance of books gave people the opportunity to have a choice; it is no longer possible to read all the available books as one could do in the past, in the 18th century scientists were able to read all the books on one subject. Today, it is impossible to cover well-defined science fields, one has to specialise and outline a field of expertise (Sainsbury of Turville, 2007). Today, the choice of information has been impressively expanded and enriched with communication and collaboration possibilities for knowledge creation in networks of people and peers (Gibbons et al., 1994). The consequences of current technological developments on the above-mentioned reductions of scarcities will change our higher education systems worldwide, we need to educate ourselves in the appropriate skills to cope with such opportunities instead of building barriers and having denigrating discussions, it seems more favourable to pick up challenges and benefit from them. Many scenarios have been designed for future higher education structures with these consequences in mind (Bell et al., 2004; Boezerooy et al., 2008; Collis & Gommer, 2001; OECD, 2001).

7.2 RELEVANT MICRO-TRENDS

In today's world micro-trends in ubiquitous technologies and tools are taking care of the reduction of scarcities. On our way through the information age, we will certainly meet more micro-trends. In this section, we deal with developments that relate to education.

Collaboration and co-creation are activities that take place amongst people; one man alone cannot do it, hence one has to communicate. Communication here means interaction between people and machines and is 'conditio sine qua non' for learning and working in the information age. Information technology has been developed increasingly as a means to support communication. Below we will describe technological micro-trends briefly to help us catch their possible influence on education in the near future.

7.2.1 Semantic Web for Contextual Uses

The presentation of today's educational websites is colourful, rich and attractive, yet the underlying relations through hyperlinking use straight textual words. According to Tim Berners-Lee and Stephen Downes the next generation web is a semantic web (Downes, 2005).

Semantics describes the meaning of words while syntax describes the rules used to combine words to make sentences. When current search engines receive a command to crawl the web, they focus on textual words only. The results of the search are achieved through text matching, both simple and intelligent; using titles and descriptions found in full text. Simple text matching is the process of searching for similar words using wildcards (*) for, in and after the words. A wildcard in computing is a sign that represents any letter or series of letters. Intelligent matching is the process of searching for combinations and orders of words over and through documents to create patterns that match the search criteria, even statistics are part of such searches.

The semantic web will add intelligence through natural language processing and probably automatic translation. Other artificial technologies such as data-mining and machine-learning add even more inanimate intelligence. The next generation semantic web will adapt to its users by analysing the person's behaviour (Baraniul, 2008; Berners-Lee et al., 2001). Such technology will help the future learner looking for appropriate learning materials in the vast number of free objects that learning malls will provide. The intelligent client software will build an appropriate profile of the learner, knowing his or her interests, learning from his or her behaviour over time and building a history of interlinked materials.

7.2.2 Sign Language for Speed-Reading

Text is an important way to communicate orally and in writing, offline and online. Many modes of communication are present in our society, mixed modes, referred to as multi-media communication are increasingly gaining a place. Signs and symbols are commonly used in our daily life each has an intrinsic quality of instant significance and meaning. In order to explain such significance and meaning one can take ordinary examples from around us, such as traffic signs for circulation rules, the presentation of artefacts in thumbnails from books, photographs and clothing, the illustrated books of infants and youngsters where nouns are presented with pictures, the 'play' and 'stop' buttons on media equipment, and the emoticons used in electronic chatting to add emotions to short textual sentence communication patterns.

Semiotics, the study of signs and symbols, is used to explain what pictures mean and how they are used. The American, Charles Sanders Pierce (1838 - 1914), with a more philosophical approach, to meaning and the Swiss, Ferdinand de Saussure (1857 - 1913), with a more linguistic approach to semiotics were seminal workers in this field (Lubbe & Zoest, 1997a). Rules must be communicated between groups of people so they can understand each other. One has to know rules to play a game or to operate in a situation (Nauta, 1997; Schuyt, 1997).

Signs in the form of pictures, thumbnails, or the like, have the intrinsic value of instant recognition. Reading signs increases our speed of reading tremendously, hence we may better call it *viewing*. Viewing signs needs its own conventions and syntax rules to standardise this form of communication (Schuyt, 1997), explanatory text is added to set out deeper meanings of a pictorial object and to explain context. The future learning malls may probably present their learning materials in categories represented in iconic and pictorial ways. Scanning pictorial OER shelves will tremendously speed up the search and browse strategies.

7.2.3 Multi-Medial Learning Materials for Pictionaries

If sign language becomes more formal, international *'pictionaries'*, as we would like to call libraries of images, codes and descriptions, must be composed alongside local language dictionaries. Today, many artists on the internet already use sets of icons for specific professions, they have created a movement for sign languages.

International *pictionaries* will probably ease global communication, which stretches much further than using English as lingua franca. When such will happen is hard to predict. What we do know is that infrastructural technologies are becoming very fast, tomorrow's internet infrastructures will have the capacity to transmit stories in high definition pictures and video without delay (Berniker & Beard, 2003).

There is already an enormous increase noticeable of video lectures available online. Universities work hard to put multi-medial materials online, broad-coasting institutes offer live streams from their television channels and archives for looking up missed transmissions. The upcoming micro-trend is video-conferencing between multiple universities to support interactive lectures and group work. It seems valid to say that in the near future learning tracks and materials will be presented in graphical and multi-media ways. Perhaps they will be stored and indicated using educational *pictionaries*.

7.2.4 Course-Shopping for Personalised Learning

Mono-disciplined education tracks still stand strong in today's universities. The Bologna agreement (1999) divided higher education within Europe into bachelor and master tracks. Educational tracks, especially the bachelor ones, are used for promotion and advocacy, and institutes teaching bachelor tracks compete for students, consequently, a need for personalisation has led to a need to adapt these tracks. Such adaptation became possible with the possibility of minors. Deepening the core of the subject whether to broaden it with new materials, for instance on sustainability, or to make it more accessible, has become a way for personalising an educational track to one's need.

Slowly the package of additional courses to choose from is growing, inherently students will develop some sort of shopping behaviour to fill their personal learning tracks with courses of interest or need. Today, the free space in their curricula is worth about 15 to 30 study credit points (ECTS) at the Delft University of Technology. Sometimes it is possible to do a track of sequential courses, even at other universities, but to date most of the free courses are done as independent and stand-alone pieces.

7.2.5 Branding for Organising Rings-of-Universities

Personalisation of education has developed to a more open choice format due to the subdivision of educational tracks into bachelor-master and major-minor tracks. Inherently; universities are repositioning their core curricula. Universities increasingly work together to enrich their educational tracks, and to arrange learning possibilities for this personalisation.

Universities with different *'brands'* (Sainsbury of Turville, 2007) will probably cooperate in what we call 'rings-of-universities' to fill the landscape of professions. Branding is the act of giving an institute a particular design or symbol that is used to advertise its products and services (Cambridge University Press, 2001). Universities must concentrate on core curricula and put them as their brand to demarcate them from other institutes. As a result every university partner behaves as *'node'* in the ring. Such cooperation is only possible when the many issues regarding credits and payments are agreed between institutes. This form of practice, once worked out will probably take a few decades before being common practice.

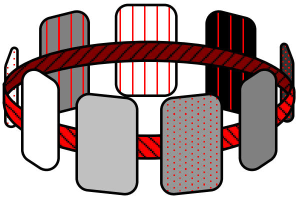


Figure 74: Ring-of-Universities with Core Brands

For now, we can discern global and regional levels of cooperation between universities. Global rings-of-universities are found at faculty and department level, with individual scientists as members of the scientific communities. Such rings already exist for research and are not aimed at education, except for graduate and PhD trajectories. Regional rings-of-universities are found at institute level and are aimed at both research and education. Cooperating rings often started as sister-universities and were designed to exchange teachers and students. The exchange was aimed at peer-levels and similar brandings. With multi-disciplinary education more distinguished rings-of-universities will emerge that cover complementary brands for geographical regions to facilitate the students as members of such rings.

7.2.6 Concluding Remarks

Referring to question q "how open access artifacts, as free learning materials for everybody, will influence the university's position", posed in Section 3.4.6, we get a picture from literature that universities will organise themselves into rings-of-universities, however, …

Multiple discussions have taken place and continue about the position of universities (Altbach et al., 2009; Bradwell, 2009; Davidson & Goldberg, 2009; Gibbons et al., 1994; Melville, 2009; Mohrman et al., 2008; Sainsbury of Turville, 2007; Salmi, 2009), financial discussions for more subsidies, the mobility of students, competitiveness, the use of ICT in the classroom, the collaboration of institutes, open access for research studies and the licensing of learning resources.

The micro-trends indicate such ongoing discussions in a more concrete way, using literature and unpublished sources, such as blogs, ideas and news. We abstracted all the information on five micro-trends to build a picture for the future. Universities are entering an era with growing competition, and they have to think over their current position, such as how they focus on core curricula as clear brands, on cooperation in rings-of-universities and how such can be brought about, on the way in which they offer open educational resources. The number of open educational resources is growing (Iiyoshi & Kumar, 2008), institutes present themselves as front-runners, and learning materials are becoming rich with full multi-media, and learning objects even with materials that will evolve to support self-instructed learning (Carneiro, 2007). The OER-related institutions will organise themselves into more robust movements (Baraniul, 2008; Iiyoshi & Kumar, 2008), culminating in possible trends for the standing universities.

Students tend to shop for more personal education tracks and choose appropriate learning materials to complement their chosen major or master tracks. Such mono-disciplinary expertises, covering know-that, know-how and know-why, are important when they have to choose for an institute. However, authentic projects that have hit the news worldwide are emerging as attractive advertisements for the competition of appealing to students. As a result, education must deal with increasing interactions between multiple disciplines, asking for communication skills, in multi-medial ways, over domains, at all times, and from man to machine.

7.3 RELEVANT EMERGING TECHNOLOGIES

Referring to question p "how information technology eras are related with educational technologies", posed in Section 3.3.6, …

There are four discernable eras in IT innovations: the 'electronic data processing era', 'computing and database era', 'internetworking and communication era', and 'portal and repository era', see Figure 11.

Indications for an emerging fifth era are already discernable, such as:

- the next generation Internet protocol version IP6 has been in place since 1999 (Gaffin, 2007)
- the world wide web as a technology, which has served us since 1991, with its easy user interface, has begun to make place for the semantic web using hyperlinking based on intelligent contextual object linking (Downes, 2005)
- back-office processes from companies have been developed into web services for automated intelligent handling in logistic processes (Tewoldeberhan, 2005)
- end user applications are growing from text-oriented to graphical user interfaces (GUI), speech is emerging slowly as an easy means of command operation
- file-servers and database servers are evolving into repositories of learning materials or other virtual objects. Repositories from all sorts of domains and regions can be harvested to know where objects are stored (Iiyoshi & Kumar, 2008)
- the speed of wireless networks is increasing. Somewhere in the 2030s the speed of wireless networks will surpass that of wired (Cherry, 2004)

The developments will provide the foundations for grid-infrastructures (Foster & Kesselman, 1998). Grid infrastructures are large scale distributed computer networks used to share computer power for calculation and storage purposes. A typical feature of grid-infrastructures is the geographical spread of logical components over a network. Two services that are operational and built on grids are cloud computing and software-as-a-service. These are built on the principles of sharing and combining resources for powerful applications.

Communication protocols have been standardised for working collaboratively, systems can communicate intelligibly over different domains and geographically spread places, information and data from different domains can be exchanged and systems interrelated by using semantics instead of syntax. As a result, systems from different domains can *'talk'* to each other. Such talking is done through ontologies, i.e. definitions of used terms and concepts, and the relationships between these concepts (Taniar & Rahayu, 2006). In theory, ontology is a formal, explicit specification of a shared conceptualisation and it provides a shared vocabulary used to model a domain. Such modelling is used to describe the type of objects or concepts that exist, and their properties and relations, for example information gathering by handling words or a combination of words using matching on character-basis, and returning result lists where a word, or parts of it, its homonyms, but not synonyms, are found. This can produce many non-results. Using semantics, synonyms and ontologies, helps to make the result lists more specific.

The above mentioned developments are slowly shaping the coming era of information technology. We want to call this era the semantic web and grid era, because multiple domains are bound together contextually. The automation of such different domains will be based on semantics for system communication with standardised protocols and shared ontologies. Typical systems to support such inter-domain exchange of learning objects are compound repositories, hence the name semantic web and grid era. The now discerned five IT-eras are shown in Figure 75, which is an expanded version of Figure 11.

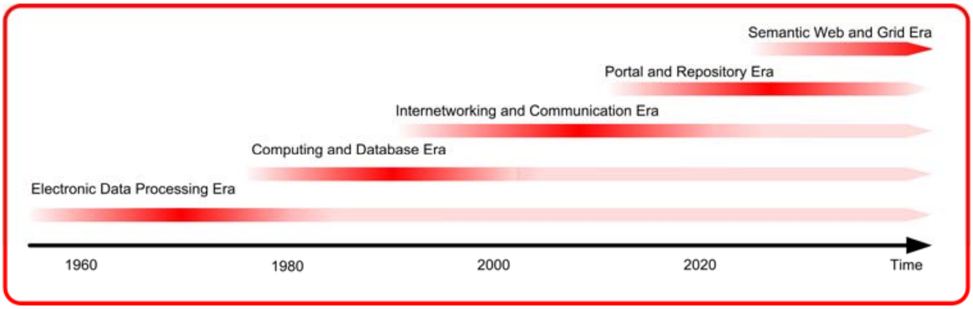


Figure 75: Overview of Five Information Technology Eras by A.H.W. van der Zanden

7.3.1 Concluding Remarks

Referring to question k "how successive technological innovations, presupposed that a next Kondratieff wave is to emerge around the 2040s, coincide with an educational technology forecast", posed in Section 3.2.3, we are very uncertain, however, …

Many educational practices today are built on the technologies of the several IT eras. As we learned from our study, the electronic data processing era induced automatic test taking and statistical tools developments, the computing and database era induced computer based training, the internetworking and communication era induced online learning, and the portal and repository era is inducing learning-on-demand. Uses of artefacts shape the way of work through those artefacts; the future semantic web and grid era will probably bring educational practices that fit with the underlying technology. Grid-infrastructures and intelligent user's interpretations will handle interactions between repositories of multiple disciplines while semantic interfaces will serve users with personalised services. User profiles will command the intellectual support technology and present appropriate materials for study or assignment. Such practices are what the *Learning mall* is about, moreover, one has to be grid literate to operate in the *Learning mall.*

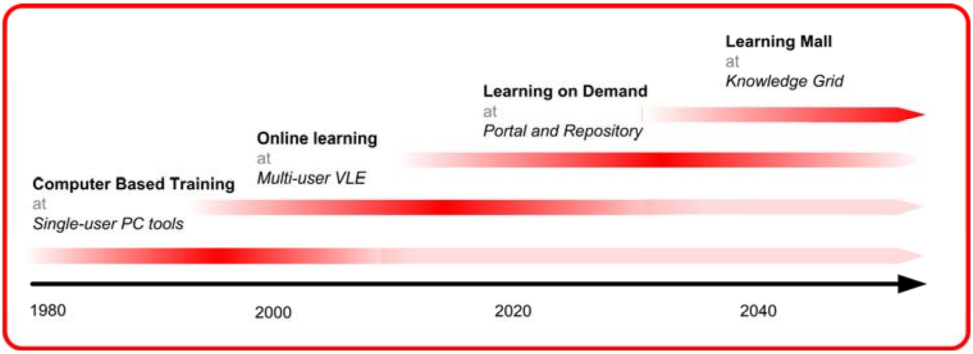


Figure 76: Four Successive Educational Practices with underlying Educational Technologies by A.H.W. van der Zanden

7.3.2 Grid Literate

commanding
viewing
applying
co-creating
co-producing
reflecting

An important development, which is gradually seeping into computer equipment and IT in general, is speech support. Today's operating systems and computer applications support the use of speech-commands. The keyboard may become redundant in the coming decades, speech is certainly a serious competitor. *Commanding* a machine was initially introduced to help those with repetitive strain injuries (RSI) or to help the disabled. To date, systems that can be commanded are not yet common, however, many computer users use a headset to talk with people on the other side of the network and improving audio techniques will lead to the development of easy to use high quality off-body equipment. So why not these factors in the near future?

With the headsets becoming more user-friendly in hands-free operation it seems only logical that people will command their tools in due time. Spoken words will be translated instantly by the system while the user dictates. Transcription of technologies that work from spoken word to electronically written text and from electronic text to computer-generated spoken word are becoming common. Initially, only flat texts have been converted, in time emoticons and other iconic pictures will be introduced to convey feeling in the transcripted sentences. The textual sentences will contain images and will slowly evolve into pictorial phrases. Picture reading or *viewing* is very natural but international conventions will need to be set in place and this will take time. Once agreed, viewing pictorial phrases will probably replace normal online reading. Viewing and commanding the systems will be natural skills in the future. Interaction between man and machine will become common place as will interactivity with inanimate systems.

Communication between man and machine will change and the mutual interaction between systems will increase enormously. Today, the web servers and services support interaction, logistic machines order new materials when a stock runs down, harvesting is used to provide lists of available and obtainable objects from available repositories. These processes are evolving into intelligent exchangers of objects done by machines that operate in grids, both wired and wireless. In addition, such grids of repositories will become virtual knowledge centres for courses and educational tracks, for facts and figures, for methods and techniques. Such virtual knowledge centres are ideal for the student to collect learning materials, and will fit well with personal learning tracks.

The educational practice will facilitate future student and life-long-learner with the possibility to *shop* for the appropriate objects just-in-time, just-for-you, and just-enough. Such educational practice is the *Learning mall* as we mentioned before. However, the personal learning track is to be completed with a bachelor or master thesis under the supervision of a university when a academic degree is gained for, *applying* for such thesis internships carries its own skills in a more competitive world, probably *collaborative creating*, *collaborative producing* and inherently *reflecting* will be future skills as well.

7.4 ANSWERING RESEARCH SUB QUESTION C

We discussed several developments in IT, disappearing scarcities due to technological developments, emerging trends due to appropriation and structuration of such technologies, possible effects for the near future, technologies and their practices and corresponding literacies. This allows us to answer research sub question C *"What are the new educational technologies coming to the university?"*.

The components we have discussed are presented in Figure 77. We placed all components in a futures wheel composition to present the landscape of educational technology and its influences. Educational technology is placed at the centre of the wheel, in the first ring the categories are placed that influence the shape of educational technology, the discerned elements of these categories are found in the outer ring, connected with spokes. There are also mutual influences amongst the categories. Note: support organisations will be discussed in Section 7.7.

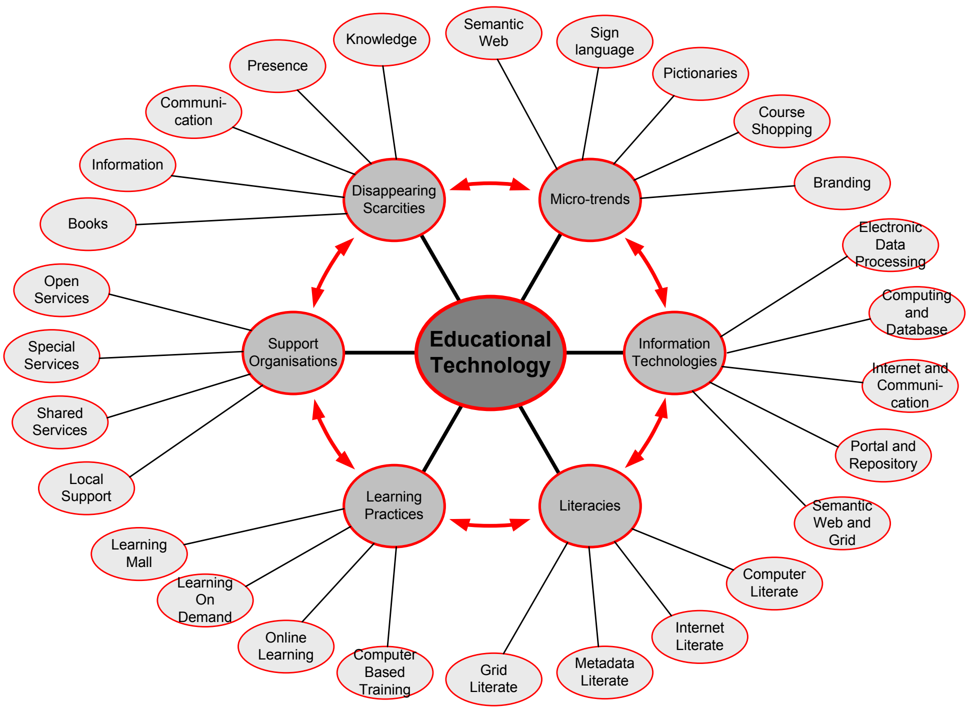


Figure 77: Developments influencing the Shape of Future Educational Technology by A.H.W. van der Zanden

The developments in Figure 77 influence the possible shape of educational technology for the near future. This shape cannot be precise, because the future holds too many uncertainties, the predictions can be used to give and to point to the way in which higher education is heading.

The next generation university will be a node within a network of universities, virtual rings-of-universities will cover complementary brands (subjects), mono-disciplines teaching the know-that, know-how and know-why are required to become an expert in a chosen field. Although many discussions have centred on the end of the current educational system we believe it will remain, however, with adaptations and a greater focus on shifting to multi-disciplinary collaboration. The new education system will build on today's system, it will take the main focus but will not make current systems obsolete. The strong power of open educational resources will cause the epistemological knowledge held at universities to be put online for free, available for everyone. Having the guardianship of such knowledge was the trademark of universities in the past days, the future requires a new strategy.

The *learning mall* is one possible form of practice that fits with the free distribution of learning materials, higher mobility of students both physically and virtually, and with the globalisation of networked universities. It forces a university to focus on a brand, be competitive and to be attractive providing authentic student learning projects. The making and co-creation of scientifically sound products and services, as end-products of authentic projects, that are sold to generate extra income, might become a new business model. We will elaborate on such valorisation in Chapter 8.
The making and co-creation in mono- and multidisciplinary collaboration, produced under the supervision of the university, will also provide interesting advertisements to attract new students. Being a project-member of such valorisation projects, counting as full member of such an appealing university and being instructed in inter-disciplinary communication skills for co-creation will be important future elements of any academic degree.

The student might opt to obtain an academic degree and the life-long-learner might choose isolated course modules to remain up-to-date within his or her profession. Internationally standardised portfolio systems will be used to retain learning activities, former acquired competencies, completed practical materials and other trivia; this will count towards credit points. When the student has collected enough credits points, he or she will be allowed to apply to graduate, taking a graduation track to obtain the appropriate degree in the brand (subject) of choice. The life-long-learner will receive a certificate or degree supplement to document the ongoing learning processes they have undertaken, helping them to improve their professional development within their organisation.

With such developments ahead, the mono-disciplinary university is transforming into a university focussed on multi-disciplinary learning tracks coupled with providing strong mono-disciplinary brands. Multiple universities will combine their mono-discipline expertises to form rings-of-universities to service personal learning tracks for students and life-long-learners. The university as node in the ring will be a stronghold with a certain brand and sufficient instructing teachers to teach its mono-disciplines. Expert teachers will take care of the multi-discipline communication between and within departments and universities. They will be responsible for multi-disciplinary authentic project-based assignments. We will elaborate on this in Chapter 8.

7.5 STAGES MODEL FOR EDUCATIONAL TECHNOLOGY

Referring to question a "if educational technology, as instigator instead of being considered as a catalyst, can lead us to future educational practices", posed in Section 2.1, we will work out a graphical model.

Now that we have an image of educational technology, of its past and of its future, it is time to bring the connected parts together into a graphic overview with a timeframe. Educational technology evolved from the introduction of corporate technologies into the classroom and learning. Four successive eras of informational technology are presented in Section 3.3.6 that can or were used to create educational practices. The first electronic data processing (EDP) era was built on mainframes and gave educationalists the opportunity to automate test taking, however, the technology was expensive and dedicated to business processes. The second computer and database era gave educationalists a more easy opportunity to build courses using PCs. In the Western world, the diffusion of the PC was vast and widespread, today one may say that almost every household and classroom contains a PC. Having a PC is as natural as having electricity, almost just as natural as having Internet at hand. The Internet was induced by the third IT era and its growth has not ended yet. Meanwhile the first signs of the fourth IT era are emerging along with its corresponding learning on demand educational practices. Projection from former sections show us the fifth IT era which probably consist of, what we call, *learning malls* coupled with appropriate learning practices.

7.5.1 Building the Timeline of our Stages Model

We discussed evidence how the uses of VLEs has grown along an S-shaped curve in Chapter 5. The VLE is built on the technological infrastructures of the 3rd, networking and communication, IT era. The works of Nolan (Nolan, 2000; Nolan & Croson, 1995; Nolan et al., 1992; Nolan & Gibson, 1974) present multiple S-shaped growth patterns for successive technologies within the theoretical framework outlined in Section 2.4.2. The works of Christensen, of Van Wijck and of Foster supports the existence of these successive S-shaped curves.

If we take the Kondratieff cyclic waves (Alexander, 2002; Foster, 1987) discussed in Section 3.2.3 and the push factors of Collis and Moonen (Collis & Moonen, 2002) discussed in Section 3.4.3 we can apply similar growth patterns to successive waves of educational technologies. As a result, we can apply S-shaped curves when placing successive educational technologies on the timeline. The educational technologies induced by the multiple IT eras are presented in Figure 76. We will follow the same time slots knowing that education may have a few years lag on the corporate sector. This allows us to construct the X-axis or time axis for several generations of educational technology. It seems fair to take the S-shaped curves of the VLE with a lifespan of about two decades as we learned from our findings in Section 5.2.4. The length of the CBT S-shaped curve is also about two decades, according to Bates, Collis, Nolan, Rosenberg and others (Bates, 2000; Collis & Moonen, 2002; Nolan, 2000; Rosenberg, 2001). Computer based training dominated from the 1980s to the 2000s, around the millennium online learning took over. This dominance switch can be seen in the overlap of the two S-shaped curves of CBT and online learning.
Online learning technology was rolled out and set to work during the overlap period, while those using mature CBT attempted to keep the dominant pedagogy. Such overlaps have a timeframe, known as *discontinuity* (Eijnatten, 2003; Nolan & Croson, 1995), that have a timespan of about 3 to 7 years. As mentioned in Section 2.4.2, it are the education support organisations that have to undergo firm changes in their structures during such discontinuities. We will elaborate on the discontinuities in Section 7.7.

If we travel forward in time, and consider our empirical findings, online learning will endure until about 2020, however, somewhere around 2015 the learning on demand practice will become dominant. If we estimate the learning on demand lifespan also at two decades then it will endure until about the year 2035. And when we consider a discontinuity's lifespan at between 3 and 7 years and consider the discontinuity between learning on demand and learning mall, the learning mall can be expected to emerge somewhere in the 2030s.

7.5.2 Building the Uses of our Stages Model

If we consider the works of Nolan, Van Wyk, Christensen and Foster (Christensen, 1997; Foster, 1987; Foster & Kaplan, 2001; Wyk, 2004) we notice that the successive S-shaped curves are placed on top of each other. That placing on top comes from different successive technologies. However, the new products may only be developed because of the availability of accumulated knowledge from earlier products. Thus we need to refer to the Adaptive Structuration Theory of DeSanctis cum suis discussed in Section 2.3 who argue that people will adopt technologies slowly when using them (DeSanctis & Poole, 1994). Bloom com suis (Bloom, 1956), as mentioned in Section 3.6.9, argue that knowledge skills are built in degrees of difficulties, which corroborates with the former theories when we argue that several literacies, for using educational technologies of Section 7.4, also build on top of each other. To give meaning to cumulative literacies, as described in Section 3.4.6, one has to master the client technology before connecting to the Internet and one has to be familiar with the Internet before web technology can be understood. Consequently, we composed the cumulative ICT uses using the discerned literacies on the Y-axis of our Stages Model.

7.5.3 Placing the Educational Practices and Technologies

To date, published research papers consist of innumerable case studies and personal descriptions but there are few research-based constructs to help us gain an in-depth understanding of e-learning in higher education (Garrison & Anderson, 2003). We believe that we have to stand on the shoulders of the current educational research body to look forward. We will take the discerned educational practices and technologies discussed in Chapter 3 and set them out on the timeline versus the literacies as its uses. Our empirical findings were transposed to timespans of two decades for educational technologies and used to design a stages model for successive educational technologies.

Our first S-shaped curve, is that for computer based training (CBT), this represents the period of single-user tools. The computer, set to work for office applications such as text editing and spreadsheet calculation, made its entrance within education and was brought into use for mathematics, computer-aided design, simulation programs, infinite calculation methods, producing test result sheets and the like. The S-shaped curve representing the CBT implementation period is placed in the bottom left corner of our graph. We could start with the EDP era as first curve, but the practices were so few and diffusion of the technology so limited that we chose to start with CBT as the first major educational technology that had wide spread use.

Our second S-shaped curve is online learning with its multi-user tools, such as communication tools, the world wide web (WWW) and the virtual learning environment (VLE) for online courses. Lecture notes were digitised and put online, as were video lectures together with references to publications via hyperlinks. Underlying tools for two-way communication support this time- and place-independent way of learning.

Learning on demand is the third S-shaped curve, it represents the social software oriented learning environment where learning materials, which over time are steadily broken up into specified learning objects, are distributed online to meet the needs of steadily increasing numbers of multi-disciplinary educational tracks. The underlying systems will be compound systems of merged portal and repository technologies.

Our fourth S-shaped curve is the learning mall. This consists of distributed electronic virtual knowledge centres equipped with personalised-learning delivery robots based on semantics and grid infrastructures. Every student, undergraduate, graduate, post-graduate, and any other expert, professional, life-long-learner, will be able to access a learning mall where *just-in-time*, *just-enough* and *just-for-you* learning objects can be obtained. Future rings-of-universities will provide free learning materials. However, if one wishes to earn a bachelor or master's degree one will have to follow a graduation trajectory under the supervision of a university holding that major or master as a brand.

7.5.4 Graphical Overview of our Stages Model

The complete picture of the four discussed successive S-shaped curves for educational technology architectures is presented in Figure 78.

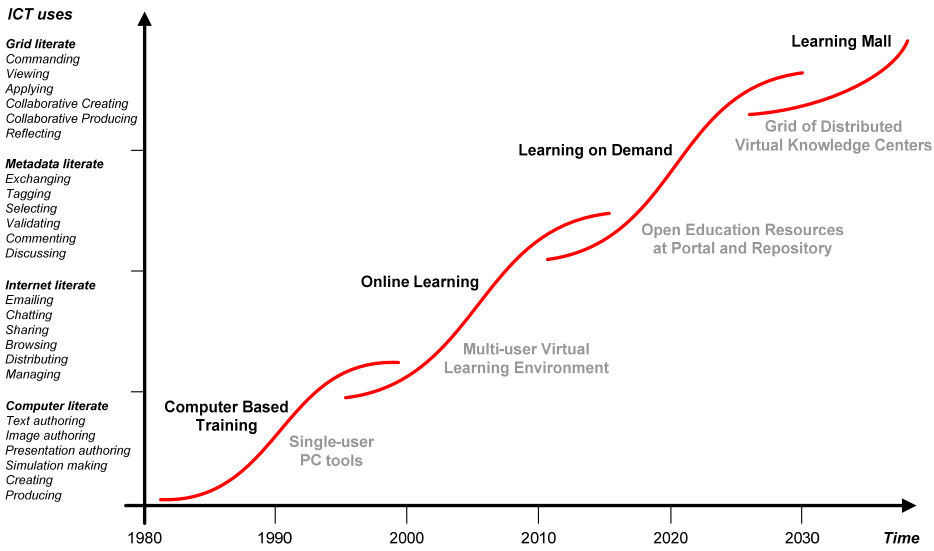
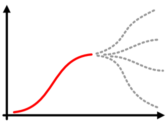


Figure 78: Stages Model for Educational Technology Architectures by A.H.W. van der Zanden

The names of the educational practices are shown on the top of the S-shaped curves, while the names of the underlying educational technologies are given beneath the curves.
The Y-axis represents the ICT uses or literacies that correspond with the educational practice. ICT uses have direct relations with the skills needed to perform the tasks related to that practice. In other words, it is assumed that the user has adopted the educational technology within educational practice of that time.
The X-axis represents the period from somewhere in the 1980s to somewhere in the 2040s; from the first widely used computer applications within education to the upcoming implementation of learning malls, where desired or required learning objects can be obtained online. The time axis shows periods with arguable dates.

7.5.5 Concluding Remarks



Although the S-curves seems to come abruptly to an end at the top, this is not true, and it remains unclear how the path will continue. As described in Section 2.4.2 it depends on several circumstances as to how the path will develop, for instance, when geographical course materials are outdated, i.e. because borders have changed due to a war, an abrupt ending can appear, and for products that are reaching their economic or technological lifespan a normal cutback scenario may be followed. Yet, it may be possible that an educational practice continues for economical reasons, because there are added functionalities due to be added, for maximum exploration in other areas, or for reasons of preservation.

Only a part of the fourth S-shaped curve is showed because its final form is reasonably uncertainty. We have composed it following an elaboration based on our findings. Even if the learning mall does not emerge as described, the idea can still be used to give the management of higher education institutes a direction in which education could go.

We think that the stages model is firm. We argue that the single-user tool is here to stay. New tools or other types of clients will replace the current PCs and their users but they will remain client systems. The second S-shaped curve represents the network level and is also there to stay. However, formal institute's infrastructures are becoming blended with open structures and such architectures may be transformed into grid infrastructures in the near future. As a result, the distance between client systems and learning systems will decrease, but the cumulative uses are here to stay. Such uses will be natural for the new workforce because youngsters today gain these skills inherently as they grow up.

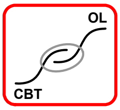
The Stages Model for Educational Technologies shows overlap periods between the several educational practices. These discontinuities need to be explained and are described in the following section.

7.6 CHANGING SUPPORT ORGANISATIONS DUE TO DISCONTINUITIES

Over the last decades, many micro-trends have come to education in general, to institutes and their users. Teachers and students have been given the opportunity to use tools such as the PC, laptop, PDA and the like, and the institutes are switching their concern-bound legacy systems for more open architectures, such as web servers and repositories (Ligthart et al., 2005; Tewoldeberhan, 2005).

As presented in Figure 78 successive technology's S-curves overlap in time. This indicates that the focus changes from one (former) educational technology to the next. According to Frans van Eijnatten the discontinuities (2003) stand for chaos, or rather for a chaordic period (Eijnatten, 2003), for changes to supporting organisations, and in the technologies used. Switching tools and systems mean that the IT support organisation also has to change its position. In the following paragraphs, we will briefly describe the change processes that happen in response to switching in the discontinuity timeframe.

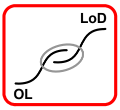
7.6.1 From Local Support to Shared Services



The first discontinuity between computer based training and online learning is caused by computers controlled by decentralised departmental dedicated staff becoming obsolete. Software companies began to develop CBT software for standardised practices in large consumer markets, such as office automation software. Special circumstances, such as those in higher education, needed tailor-made applications, developed for specific learning goals. For instance, faculties in higher education had mathematical needs, or design needs, and they hired local staff to develop the dedicated software applications, these single-user applications, not commercially available, had to be maintained and upgraded from time to time. Hence, special staff were hired to support courses, departments or faculties. Sometimes complete service departments were set up to meet the demands.

When the dedicated CBT software applications came to the end of their technological lifecycle, for instance many DOS applications had to be completely redeveloped for use on the Windows platform, and faculty management had tough decisions to make. Should they proceed with another tailor-made development or should they purchase commercial software without the specific education functions?
The advent of Internet technology paralleled these developments and gave rise to a number of alternatives that could be used to meet the faculty's needs. The VLE came onto the market which, with its underlying centralised and server-based architecture, central support and helpdesks, could be used to support the university faculties. Faculty management began to dismiss local staff or had them retrained, thus the technological discontinuity between computer based training and online learning caused organisational change. Education support services moved from a decentralised position to join a shared service concept (Wissema, 2005). It assisted in cost savings and service bundling.

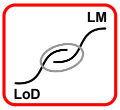
7.6.2 From Shared Services to Special Services



The second discontinuity between online learning and learning on demand represents the switch from the closed VLE systems to the more open portal platform with underlying repositories. Whereas central support and helpdesks can easily handle HTML and other low skill scripting software for online learning, the implementation of the repository systems with interfaced portals require highly specialised engineers and software architects. Staff needed to be familiar with information architectures, service oriented architectures (SOA), to have affinity with learning, and to have developed skills to communicate with teachers, educationalists and educational management (Bass et al., 2003; Ligthart et al., 2005).
Central support was expected to expand its expertise for coping with such new technologies and some tasks might be outsourced, the more general and easier, were sometimes outsourced to commercial suppliers. Again general management had and still has tough decisions to make, should the university choose to be a front runner with its learning technology and innovate, as faculties did in the early years with their tailor-made educational applications, or should it choose a follower's position?

It is easy to not disturb standing support centres and only direct attention to efficiency and transparency, but is waiting for the commercial market to come up with appropriate software, that in time will match a university's goals, a smart decision?
In the current time space, such decision can make the difference between setting the educational position of the institute as a leader or taking a more uncertain followers' position, dependent on the appearance of suitable commercial products.

7.6.3 From Special Services to Open Services



The third discontinuity between learning on demand and the learning mall will probably cause university managers to have to face another tough decision-making process. In the coming years developments on the educational market will probably force universities to merge and the commercial market will be pushing new technologies into the universities' infrastructures (Bass et al., 2003; Gibbons et al., 1994). The matching of such strong forces will undoubtedly cause new organisational change effects. However, this type of merging may shape universities into institutes with strong brands (Sainsbury of Turville, 2007). Such cooperation fits the rings-of-universities model sketched in Section 7.2.5. Outsourcing the more general services, such as email, file and printservices, and finance systems, next to interuniversity services, such as portfolio and crediting systems, will lead to efficient, effective and economic systems.

7.6.4 Concluding Remarks

A graphic stages Model is presented in Figure 79, showing the changes that effect educational technologies. As described in Section 2.5.1 *progress* and *switch* are different approaches to the adaptation process that universities go through when changing IT technologies and pedagogic approaches.

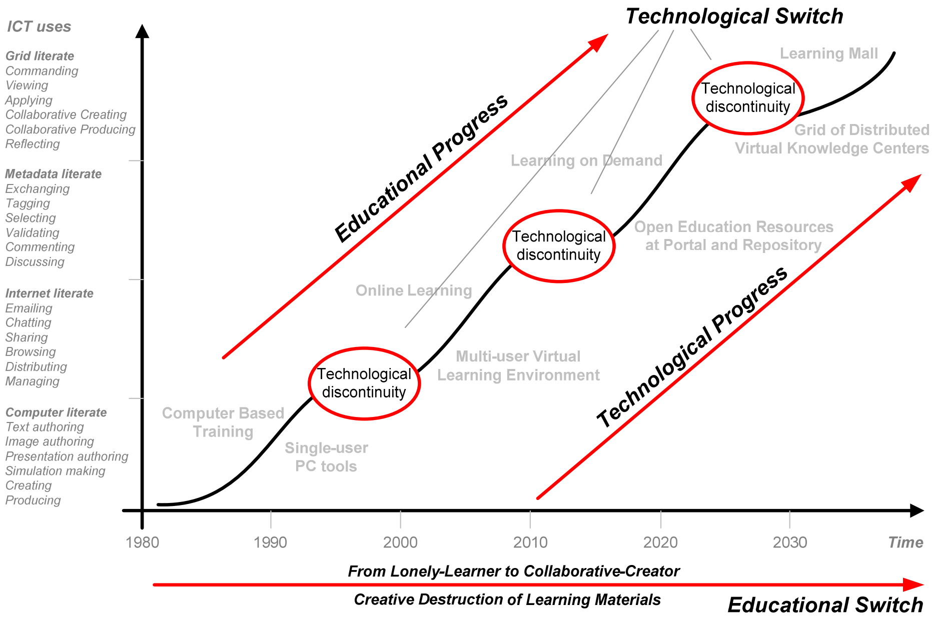


Figure 79: Indication of Progress and Switch for Educational Technology by A.H.W. van der Zanden

Progress is a more natural development which is derived our innate drive to move forward. Switch comes at the end of a track with the changeover to another S-shaped technology lifespan curve. Progress is the evolution of the S-shaped curve as it develops from infancy with technological try-outs up, to a mature state where the use of the available technology is maximised, see Section 2.3. Switch is an opposite and radical movement from one practice or technology to another in order to make an institute ready for the next period of progress. Such radical movements have far consequences for an organisation, but over a much shorter period.

In our model the *educational progress* is indicated using the different successive stages of computer based training, online learning, learning on demand, and learning mall. *Technological progress* is indicated using the different successive stages of single-user tools, multi-user virtual learning environment, portal and repository and distributed virtual knowledge centres. Both grow along the S-shaped curve patterns.

The *technological switches* shown in the model stand for technological discontinuities. After every switch, a different type of support organisation is required to help a university progress along its chosen path.

Educational switch indicates the changes in education along a timeline and along cumulative literacies from *lonely-learner* to *collaborative-creator*, from doing it alone to work in groups, from consuming knowledge to producing knowledge, from mono-disciplines to multi-disciplines. Communication gains an increasingly important place within the learning practices as the decades pass. The learning materials will change over time becoming more fragmented, they will be deconstructed in a creative way to be gradually transformed into complete independent online learning materials. When we take distance to the subject and compare education over a period of about half a century then the multiple educational technologies have caused a massive difference within the education system. It has switched from *substitution*, with technologies used to support educational processes, to *transformation* where the technologies will built an education system that cannot exist without these technologies. *We are heading for a next generation university*.

7.7 CONCLUSION

We collected the developments that influence educational technologies and used them, to shape a possible image of future higher education. Educational technologies are influenced by disappearing scarcities, paralleled micro-trends, developing literacies, successive information technologies, adapting learning practices and appropriate support organisations. We presented these developments into a futures wheel diagram, then we projected the educational technologies on a timeline to obtain an historical evolutionary overview and called it the "Stages Model of Educational Technologies".

Elaboration on possible futures is often done using scenario planning, that is by deliberating over possible stories of alternative futures with, most of the time, two opposite axes leading to four possible practices. Many scenarios for future higher education environments have been designed by many collaborative platforms. We took our VLE growth curve evidence and used it to estimate the lifespans of other institutionalised educational technologies, we set them out in the stages model for educational technologies and elaborated on fitting practices. Appropriation and structuration of apparent educational technologies gives such fitting practices, surrounding technology artefacts make users shape their uses. Combining collected micro-trends with our stages model for educational technologies gives us an opportunity to discern several building blocks that will shape the appropriate surroundings for the next generation university.

Our Stages Model of Educational Technologies presents the landscape in one view, in which educational managers will have to manoeuvre in the near future. We learned in Chapter 3 that technology is just one, but a strong, element that shapes higher education. Multiple other developments also influence higher education, we took a supported look at a possible, soundly derived, future for educational technology and will elaborate on the other influences in the following chapter.

8 EPILOGUE

"Space... The final frontier...
These are the voyages of the Starship Enterprise.
Its continuing mission:
To explore strange new worlds...
To seek out new life; new civilisations...
To boldly go where no one has gone before!"

From the Star Trek Series The Next Generation
Captain Jean-Luc Picard

8.1 THE ROAD TO THE FACILITATING UNIVERSITY

We will go beyond our empirical evidence in this final chapter and present seven key principles of which we think play a key role on the way to next generation universities. The principles aim at a possible future policy, hence, we have derived our results from literature only.

The key principles may be considered as building blocks and are ingredients that can be used to take a vanguard position. We believe that these key principles address macro- and micro-trends in university development discussed today, in the development of the next generation university, such as societal changes in the workforce; social technologies used to support online communication; connectivism as the upcoming learning theory; network as a corporate architecture model; the economic position of today's higher education; the shift from an fit-all education system to more personalised education tracks; the position of scientific design engineers next to scientific researchers; and most important of all, teaching and learning inter-disciplinary knowledge that fit in the life and work in the information age.

Working out a complete set of scenarios would demand a complete study on its own, and has not been the approach that we have taken in our research. Instead, we will forecast taking the big picture of systems from the Stages Model for Educational Technologies from Section 7.5 as our guide. In this model, the Learning Mall, built as a virtual knowledge centre, places the future university as node in a network, as a brand in a ring-of-universities, accessible for public and peers. Learning materials are open to be used throughout society and to be discussed publicly, and by students and life-long-learners alike. Consequently, future universities will function, in addition to their academic position within their professional networks, as knowledge portals for everyone, they will interconnect increasingly with public and private organisations to operate as knowledge providers and knowledge brokers in societal issues that matter (Gibbons et al., 1994;

Mohrman et al., 2008). As many other organisations, universities will function in a networked world as is shown in Figure 80.

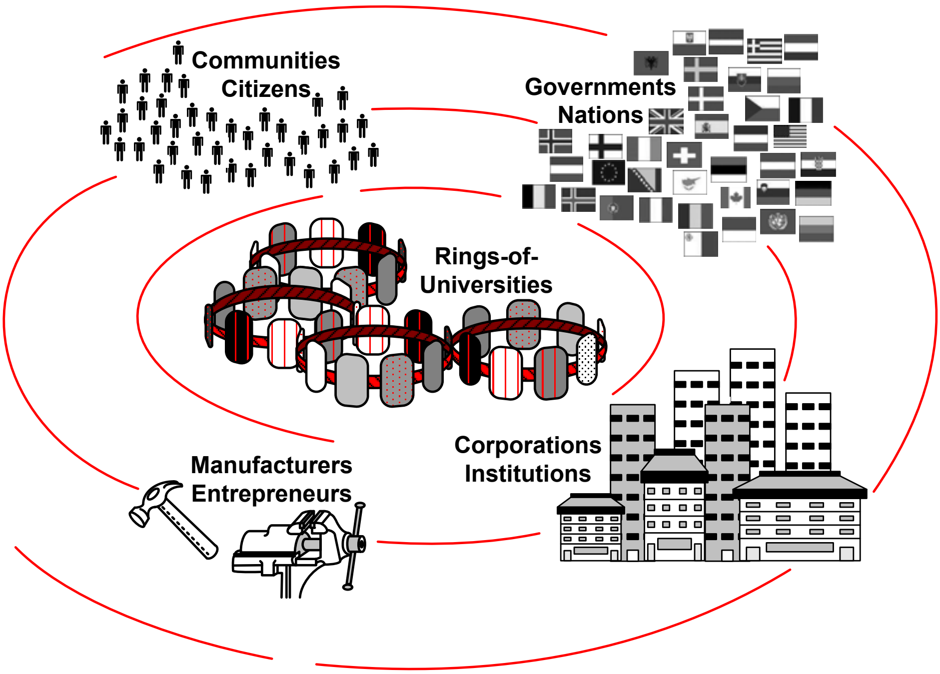


Figure 80: Nodes in Networks connect for Communication, Democratisation, Exploration and Co-creation by A.H.W. van der Zanden

8.2 HOW MONEY BECAME RULER OF HIGHER EDUCATION

Financing of higher education in Western Europe was mainly dependent on annually determined grants from the government only a few decades ago. Higher education institutes delivered their numbers of students, of degrees and PhDs, to obtain their share of a national treasury. There was no possibility to influence this share except by varying numbers, hence, Western European universities have welcomed the enormous growth in students numbers, referred to as *massification*.

8.2.1 Massification, Heterogeneity, Mobility and Personalisation

Massification of higher education began somewhere in the 1960s, and with the growth of student numbers the second generation university as *instruction factory* achieved its most mature state. Because of massification, the distance between teacher and student grew larger, hence, the master-apprentice model grew thinner. Teachers had to follow a one-to-many instructional attitude to handle larger classes. Moreover, massification had a contradictory movement as its consequence, the more students in the educational system meant a broader spread of learner backgrounds and attitudes causing *heterogeneity*. It should be noticed that rising numbers of students in higher education was an objective in the Netherlands by that time and governmental policies has fortunately resulted in a score of 47% participation in higher education today (Plasterk, 2007). However, we consider massification as happened as a more negative result of these attempts to lever higher education participation.

In the Netherlands in response to above-mentioned heterogeneity, the Dutch government modernised the education system and introduced a ‘two-phase system’ or ‘Studiehuis’ (Learninghouse) within secondary education (Hoeven, 2005; Huijssoon et al., 2007). Typical characteristics of the two-phase system are an *active learning attitude* where exact reasoning makes place for assessing and estimating, and a *planning attitude* where classroom scheduling makes place for individual planning. After a few decades of heterogeneity and one-to-many instruction some unwanted symptoms appeared in the schools such as an increasing number of dropouts (Daale & Asselt, 2007) and a growing mismatch in the connection between secondary and higher education for the science courses such as mathematics and also for economics (Gastel et al., 2007). Because higher education subject matter was not governmentally ruled, only subsidised and autonomously operated, it did not respond with a joined up strategy in parallel. On paper, end terms of secondary education fit with entrance terms for higher education (Vrie & Jonker, 2007), but over years it was found that intake and eliminating deficiencies programs were needed to fill the widening gap between secondary and higher education (Caspers, 2007; Tempelaar, 2007).

Higher education in Europe had also to respond to other policies, such as the Bologna Agreement that forced higher education in Europe to introduce the bachelor-master subdivision within the usual 4 to 5 year of educational study (Weber & Zgaga, 2004). This bachelor-master standardisation stimulated the (inter)national exchange of students (Wende, 2001), resulting in growing *mobility* within higher education. Students increasingly began to follow, parts of, their masters at other European universities in the English language, as the Bologna Agreement had proposed. This mobility offered students the chance to follow more personalised learning paths.

The additional major-minor construction of bachelor tracks that has taken place fits even further with *personalisation*, where it became possible to choose broader or more in-depth materials as minor tracks. Hence, higher education was confronted with first-year students, carrying a new learning attitude stemming from the two-phase system, at the start of bachelor tracks, and multiple international students at the start of master tracks. Such heterogeneity and personalisation has forced universities to develop even more learning tracks to fit these students into the education system as practised.

8.2.2 Educational Management shifted to Financial Management

Massification led university management to choose a more business-like management model. Since the models used by governments to calculate university grants were based on numbers of students, number of degrees, and number of dissertations produced, universities aimed to increase these numbers.

Ever since the 1960s, when higher education institutions began to welcome the ordinary man or woman to its colleges instead of only an elite, the government provided income based on numbers, which has grown rapidly. However, that wealthy situation for universities changed, all of the universities followed such calculating strategies and, since the national gross lump sum available for education in many countries diminished over the years, universities had to compete even more for a share of this revenue. Only those few universities, the first to achieve higher figures compared to others, saw a temporary growth in subsidies. Temporary, because such short-term profit was levelled out in the following years when competing universities caught up using the same strategies and everyone gained a proportional share of the available money once again. Still the universities competed for larger student numbers, and consequently, efficiency and nominal study terms became the next goals used to balance finance and cut costs. Due to such economic strategies, financial management began to focus on steering. A university's administration was tasked to work more efficiently and students were expected to study within the nominal 4 to 5 year programmes. Notwithstanding, the proportion of money assigned per student has decreased substantially and continuously according to the Association of Universities in the Netherlands (www.vsnu.nl).

8.2.3 Efficiency in Education Unbonds Students from their Alma Mater

A very much ignored and underestimated effect of such financial management is the pressure placed on the primary education process. Pressing for more-efficient studying is squeezing out free time and free space for students. Historically in the Netherlands, the students who delayed completing their courses compared to nominal study terms of 4 to 5 years, easily took one to two years more. In these extra years, the delayed student occupies a place that could be used for a first year student and that student brings in revenue, moreover, if a student finishes his or her study on time the maximum financial return is gained thus increasing financial subsidy figures. These processes in higher education began to shape an *'instruction factory'*, with students as output products. Universities simply had to be more efficient to improve financial figures.

The pressure to study faster and more efficiently meant that students had fewer possibilities to develop socially and assertively or to work to support themselves. The possibility to take seat in fraternity's or sorority's presidium, students' union, or faculty's counsel, slipped away and student bonding with their university began to decrease. Exchange students doing a two-year master study had little chance to be bonded to their *alma mater*. For management, however, the economic strategy delivers positive figures at two sides, 1) efficient student results and 2) less requests for council studentships or bursaries. These are positive effects for financial counting. Although these financial benefits seem attractive on the short-term, there is also a negative effect, students graduating and leaving their alma mater gain little feeling for their university. Alumni that have built a relationship with their university tend to keep connected to it, hence creating opportunities for sustainable social networks.

We would like to introduce an alternative for the common focus of universities on efficiency and cost cutting. This alternative way for financing universities and creating new money should be a focus on valorisation of authentic education. We want to introduce valorisation in the standing university organisation as a means to explore sources of *new money*.

8.3 HOW TO GAIN NEW MONEY FOR HIGHER EDUCATION

We want universities to expand their income in a structural way and focus on valorisation of authentic education projects as additional earning model. Valorisation is defined as increased and faster transition of research and engineering thoughts or ideas into innovative applications using market principles. We think using the valorisation principle to realise knowledge products and knowledge services through educational projects for third parties is an effective way of earning money. Ill-structured challenges, problems, projects, explorations, studies or innovations composed out of scholar, bachelor, master and PhD efforts are unique multi-disciplinary assignments.

Product life cycle management seems to be applied to students, as products that are valorised on their way through university. Yet students do not produce more money for education when efficiently led through their academic years. Their intrinsic value has increased but education has not profited from this. Today's universities see students as 'university products', but instead, we should position them as 'university's producers'.
Taking an opposite view, we should ask "*what can students mean for education instead of what education can mean for students*". We consider students being worth indirect money and we think education is not harvesting it. As producers, students can deliver valuable knowledge in valorisation projects and consequently represent hard currency. Besides this financial aspect of working with valorisation projects, there are other reasons to let students work in such activities. The first one is that students should consider themselves as member of the academic community developing strong ethics about issues such as independency of an academic, societal responsibility and applicability of knowledge in society. Another reason working with students in authentic valorisation projects is that motivation is a strong factor in learning.

We want to give this valorisation of educational projects a place in current universities' organisations, hence, we start to describe the input-financing model in the following section, followed by valorisation of research, ending with valorisation of multi-disciplinary projects as first *key-principle*.

8.3.1 Input-Financing follows University's Hierarchy

University funding follows an input-financing model for allocating money to faculty and department. All state universities receive a share from the national or state income, called '*lump sum*' or first-order money-stream, via a complete reallocation process, every calendar year. This process follows a top-down flow equal to a university's hierarchy from executive to faculty, to shared service, to department, to chair, as shown in Figure 81.

The input-financing flow is container-oriented, just as the first generation business IT systems (Nieuwenhuis, 2003). The container-orientation follows faculty borders, which historically came from the mono-disciplined boundaries of the 2nd generation university (Vogt, 2005; Wissema, 2005). The allocation process directly involves the budgets of faculties and departments, once the allocation is determined, it is almost impossible for a faculty or department to acquire extra governmental finances for additional projects appearing in the same calendar year. The model is reliable, though inflexible, and strengthens a bureaucratic way of management. Lump sum assignments follow numbers of registered students and degrees at the national level, the university's level and even the chair's level. Chairs, at the end of line, take a small share to pay staff salaries.

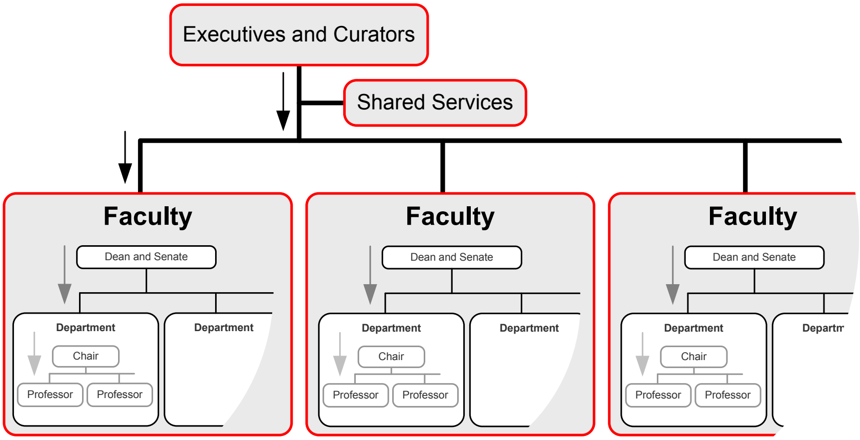


Figure 81: Budget Allocation follows a Container-Oriented Top-Down Flow with Input-Financing Model by A.H.W. van der Zanden

A challenge to input-financing models occurred when students opted to take additional courses at other faculties in parallel to their planned educational tracks. When a student is registered at one faculty and he or she wants to enrol on a course at another faculty then that faculty wants a fee to be paid to cover the costs of educational services to a non-faculty student. However, since students only count once for a university's lump sum and are assigned to one, and only one, mono-disciplined faculty, there was no way to pay the other faculty. Students have increasingly followed courses at other faculties, and, in response, universities introduced administrative frameworks to provide for appropriate interfaculty payments. However, these frameworks for horizontal cash-flows had to fit in the standing input-financing model. As a solution, assessed parts of the university's governmental lump sum were set aside in the former calendar year to facilitate interfaculty payments after a period of cost determination, causing a delay of at least 2 years for interfaculty payments. A drawback of this sytem is that unpredicted increasing numbers of students can opt to follow courses at other faculties resulting in unfair divisions of money. The earlier annual allocated budget had to be divided by higher numbers, and this had continued over the years due to the ever-increasing numbers of students taking inter-faculty courses.

8.3.2 Valorisation of Research is already in Place

Only a few decades ago, most universities in the Netherlands and much of Western Europe were completely funded by the government. Since the 1970s, additional financing flows have come into place to finance research programs. Thus, doing research earns money in addition to the national subsidy. In the Netherlands, such extra income is acquired from Dutch research institutions, such as the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO), income from the national subsidy is called first-order money-stream and income from KNAW or NWO is called second-order money-stream.

Parallel funding can be obtained from European research programs and universities set out to acquire funded assignments from companies, government, dedicated research institutes and charities. This income is called third-order money-stream. Moreover, following the American model the idea to recruit companies to finance chairs and parts of research activities gained ground and collaborative projects between universities and companies have in some cases grown to partnerships.

Universities as knowledge incubators are increasingly becoming an important intermediary between innovative knowledge and its valorisation by companies. Valorisation comes from fundamental research, design, creative products, engineering and software applications. Entrepreneurship has been encouraged in the last decade by governments and higher education to valorise university products (Plasterk, 2007).

An appropriate credit system was set up for research publications and proceedings to value the efforts of related researchers, stimulating university teachers to research, publish and create track-records and earn status and money. Valorisation centres were established to support money-streams for research activities. Mixed funding, that is to say first-order, second-order and third-order money-streams is now commonly used to fund research, however, comparable structures are still lacking for education. We would like to defend the approach of mixed-funding strategies for educational activities as well! Considering the idea of entrepreneurship, new innovative spin-off can come from graduation projects and PhD trajectories. Education seldom profits from these student activities and even worse, those students starting a business just take their ideas developed within the framework of their education, to turn it into products that sell, holding all rights to valorise intellectual properties and not sharing any profits with the university. In fact, we might say this system is a one-way *brain-drain*, the university provide resources and help the student to develop the business, but returns remain elusive!

8.3.3 Valorising Competitive Multi-Disciplinary Education Projects

Referring to question i "how valorisation as third primary process can be embraced and implemented within higher education", posed in Section 3.1.4, we want to focus on competition.

Competition is a well-known issue in education. There is competition to recruit students to gain higher subsidies, rankings of universities to obtain a better image, visitation committees to show subject matter quality and track records. However, the competition of universities to acquire and excel in multi-disciplinary projects is still poorly developed. Such projects can lead to innovative applications, services, solutions, and consumer products e.g. low energy cars, non-friction boats, domestic robotics, medical tools, stronger plant seeds, solar driven heating, autarkic biotopes, easy cleaning water supplies, etcetera. A perfect example for Delft University of Technology is the Solar Challenge where participating universities design and build cars that have to cross the continent of Australia using only sunlight as fuel. DUT won the challenge successively in 2001, 2003, 2005, and 2007. Many educational institutions and corporations come together to support products like the Solar Challenge. Winning such challenges delivers great public relations for universities and corporations, however, does not deliver hard currency in the university's purse. We suggest to structure such multi-disciplinary projects in such a way that they can generate extra income for higher education institutions.

Authentic multi-disciplinary projects come from governments, social and civil services, research institutes, corporations, companies, small and medium enterprises, or other formal institutes, that have an innovative idea or are faced with ill-structured problems. Multi-disciplinary authentic projects are complex and interwoven with technical, social, environmental, sustainable, ethical and aesthetical issues. They need multiple formal arrangements before they are operational. In our view a third generation university organises a clear platform for external institutes and other third parties to discuss proposals with university professionals and to submit such proposals. This type of project management and execution arrangement is required for education to earn money, and this leads us to propose the third primary process: the process of Valorisation.

Key Principle 1 – Valorise education by delivering products and services for third parties with hard currency in return. Subsequently, introduce income for valorisation projects as a fourth-order money-stream.

8.4 Defining Authentic Multi-Disciplinary Valorisation Projects

Referring to question g "how the cyclic innovation model (CIM) can be applied within higher education to prosper an entrepreneurial state of mind", posed in Section 2.4.3, we want to position it into the valorisation projects.

Second generation universities focussed on students as products. They counted figures for first-years, numbers of delivered graduates, numbers of delivered PhDs and article outputs in proceedings and journals. Those are the tangibles of the old days! It is not wrong but outdated. Today, people and their intangible knowledge should count for much more, these entities being the engines of wealth creation (Bryan & Joyce, 2007). Bryan and Joyce argue that we should create wealth by converting knowledge intangibles into institutional skills, patents, brands, software, customer bases and networks. Such intangible knowledge is the resource used to produce tangible services and products. All sorts of management tools are available for tangible services and products, but management tools are still rare for intangibles, as is credit in money paid for them.

The valorisation of multi-disciplinary education projects follows normal project management procedures and delivers a service or product. Such ill-structured projects contain packages of combined mono-disciplines to make them work and these disciplines are linked to form a complex chain of activities. This linking of multiple mono-disciplines is where the challenge is and where higher education still offers a rather blank field. Only a few courses deal with inter-disciplinary linking, see also Section 8.5.

The complex chain of activities is built on ideas taken from the corporate product Value Chain. Michael Porter proposed the 'value chain' concept for business management in his book "Competitive Advantage, Creating and Sustaining Superior Performance" (Porter, 1985, 1998). A value chain is a chain of activities through which products pass. With each activity, the product gains some value. The university should capture such value generation for complex authentic assignments. Selling academic knowledge for hard currency or valorising educational projects is wandering a blank path. Such approach for higher education is new but may turn the processes of efficiency and cost savings into an entrepreneurial state of mind.

Porter's value chain is focussed on mass production and business competitiveness but the educational projects value chain should focus on supporting unique, authentic, complex, sustainable knowledge projects. University professionals need to convert ill-structured real-world problems into outlined project descriptions with a structured outcome, using decomposed mono-disciplines and assessments for work and study hours, to gain credit points, and supported with the supporting activities necessary to fulfil the complex project.

Although projects on completion will be exchanged for money, the scientific approach will keep rolling on, because research and publishing will continue and such scientific output is feedback to augment and level-up a project into a successive version or following generation of a project's product. This will produce a cycle, which we would like to call the *'educational value cycle'*. We want to position the educational value cycle into Berkhout's cyclic innovation model (CIM), see Section 2.4.3. The CIM model seems perfect for authentic multi-disciplinary projects. The nodes in Figure 82 represent mono-disciplines and are not limited to single universities. On the contrary, universities will be expected to focus on specialised brands and should operate as nodes in a ring-of-universities to exchange knowledge with peer institutes for valorising multi-disciplinary projects. The cycles hold interacting communication channels between multiple disciplines.

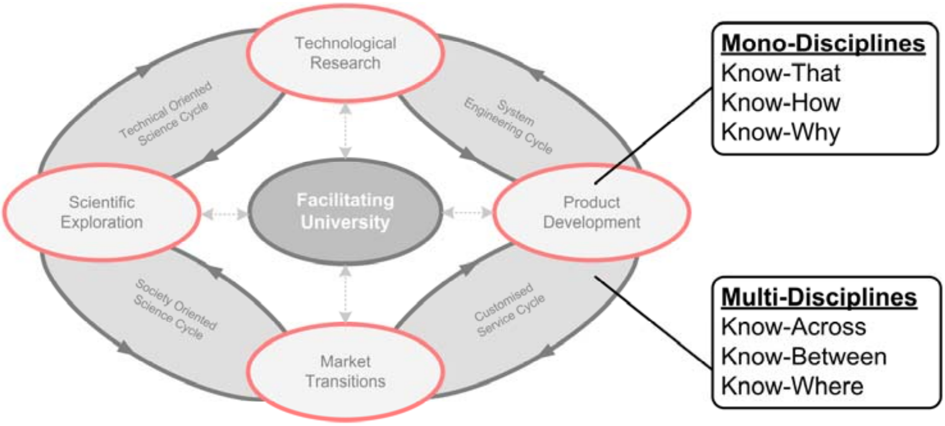


Figure 82: Types of Knowledge positioned in Berkhout's Cyclic Innovation Model

Referring to question t "which university setting can address the discerned types of knowledge within the educational practice", posed in Section 3.7.10, we want to refer to Sections 8.4, 8.5 and 8.6.

In mono-disciplines knowledge is taught in-depth that is often useful for single professions. The current education system is build around know-that, know-how and know-why knowledge, described in Section 3.6, culminating in faculties of the second generation university. Multi-disciplinary knowledge facilitates communication between professions. Interdisciplinary collaboration and co-creation is more than just talking to each other, adjusting design methodologies, dimensions, vocabularies and ontologies ask for additional know-across, know-between and know-where knowledge, as described in Section 3.6, See also Section 8.5 how universities may deal with this.

8.4.1 Acquisition and Submission Phase

One-stop-shop bureaus should obtain and guide new valorisation projects from third parties, they must be able to contact all university's chairs to counter external experts with internal professionals. Meetings to assess the project and discuss the terms of valorisation and feasibility will be required. A valorisation project travels through several phases of the educational value cycle. The first phase is the intake process from acquisition to submission. It delivers a *Project Initiation Document* (PID) as output product. Such a PID is composed using common project management tools (Prince2, 2009). The PID of a new valorisation project will consist of a brief description of the project with clear objectives, domain needs, terms, intellectual property, stakeholders, co-makership, partnership and budget magnitudes. It should hold enough information to start the next phase, project decomposition. The university should value the PID deliverable and award appropriate credits points, just as is done in the current process for publications, credits which allow faculty and staff to earn income for their department. Valorisation projects can vary in complexity, dimensions and magnitude. Hence, a '*valorisation committee*' will be needed to determine the value of a PID and award the project with appropriate credits.

8.4.2 Decomposition Phase by Subject Matter Experts

When a university and third party have agreed on the PID and have a green light, the next step is a time-consuming formal process. The PID has to be transformed into outlined project pieces. It must be decomposed into feasible sub-projects for several mono-disciplines. Project pieces hold metrics in the two dimensions level and quantity, levels stand for difficulty and are expressed as PhD, Master, Bachelor and Scholar projects, quantities will be expressed in credit points and represent efforts in hours at planned calendar times. Sometimes inter-university cooperation will be necessary, when for instance, a profession is not available within one university.

Professional experts will convert the ill-structured project into outlined pieces, domain specialists, subject matter experts and project managers will work out all parts of a project in an extended document in cooperation, and in a constant feedback loop with the submitting third party. The third party will pay a substantial amount of money for the work, which will increase if it wants to own the intellectual property or to maintain secrecy. Budget allocations for a valorisation project will be expressed in credit points just as in the current institutionalised processes for publications. The third party will eventually pay these credits to the university for dispersal and will pay directly for any out-of-pocket resources used.

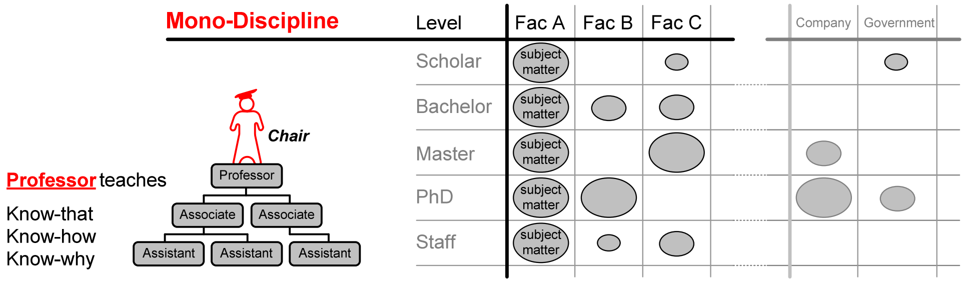


Figure 83: Mono-Discipline Subject Matter Experts assign Parts of Valorisation Projects into Outlined Pieces by A.H.W. van der Zanden

Assistants, associate and full professors will participate to define multiple parts of a project. A *'Decomposition Team'* will be set up to describe, define and set up project pieces with resources and to estimated the hours, required to do the work translating the project into discipline, design methodology, level, quantity, study credit points, and into number of instructing, coaching and study hours. Project pieces should fit in the current education system, which is based on knowledge and information, aimed at 'know-that', 'know-why', and 'know-how', the Education Qualification Framework (EQF) from the European Community, see Section 3.6.10, can be used to help. The decomposition organisation is illustrated in Figure 83.

Once all project pieces are caught and described, network planning using causability, inter-dependency and critical path analysis must be worked out. The outcome of this second decomposition phase is a Project Valorisation Document (PVD). The PVD will deliver credits for the composers. Once again a valorisation committee will set the value of the PVD.

Key Principle 2 – Organise credit metrics for the intake of educational valorisation projects (Project Initiation Document) and their decomposition (Project Valorisation Document).

Once the submitting third party and university agree on finances, resources and output, the project can be started. The hierarchy and organisation of current universities as they stand can deal with the acquisition, submission, and decomposition phases, but conducting a valorisation project will need additional measures.

8.5 Conducting Authentic Multi-Disciplinary Valorisation Projects

Decomposing a valorisation project into multiple outlined sub projects delivers a collection of isolated artefacts, such as descriptions and assignments for mechanical objects, for calculations, for instrumentation parts, for software applications, for scientific studies, for manuals, etcetera. All such artefacts are domain specified and mono-disciplined because they require in-depth knowledge for the activities. When the project starts and isolated artefacts are put together they have to fit in magnitude, in dimensions, in materials, in environment and in calendar time. These parameters must be considered during the research and design processes. Such considerations and controls concerning all parts of an ill-structured problem are a great challenge, and the required skills are not yet taught structurally within higher education. Interfacing and adjusting are mandatory parts of a project, when multiple disciplines work together separated design methodologies must match and outcomes must fit, otherwise the several parts cannot be built into a whole nor will the outcome perform as expected. A striking example of this problem was the disappearance of the Mars Climate Observer in 1999 due to interdisciplinary mismatches, amongst others a mix-up in converting metric and American units (Oberg, 1999).

Collaboration and co-creation are important for multi-disciplinary projects. students must learn these skills in a learning-by-doing setting, they should participate with the aim of practicing the inter-disciplinary skills know-across, know-between and know-where, but such knowledge has to be taught first.

8.5.1 Organise Multi-Disciplinary Educational Tracks

Communication channels between multiple mono-disciplines of valorisation projects must be organised. The design methodologies of different mono-disciplines need to be adjusted to fit with each other, the vocabularies of disciplines need in some case to be translated so the disciplines can communicate to understand each other, the dimensions of several professions will need adjusting to adapt to meet other disciplines and many more subjects will need adjustments.

Interdisciplinary skills are not organised as mono-disciplinary skills. The Education Qualification Framework (EQF), see Section 3.6.10, deals with know-that, know-how and know-why, but not with know-between, know-across and know-where. There are courses that deal with interdisciplinary skills, but these are spread and often offered as elective minors. The university should outline, complete, value, credit, level, organise, teach and instruct academic curricula using inter-disciplinary learning materials and courses. Such curricula will prepare students to bridge professions and domains wherever formal, and informal, communication takes place. One can start composing such curricula by collecting existing materials at faculties and by developing new courses in cooperation with mono-disciplines, ignoring faculty boundaries.

8.5.2 Nector as Multi-Disciplinary Professor

Referring to question n "how can the teacher's job be reshaped to face the mentioned microtrends", posed in Section 3.2.7, we want to introduce nector as additional funtion.

When a valorisation project is decomposed and documented in the Project Valorisation Document the interactions are known. This moment may be trigger to collect and develop appropriate courses, but we believe that a more structural approach is needed to be ready for valorisation projects. Once the project is initiated special education tracks covering many inter-disciplinary activities will be set up in a coordinated way. In other words, several mono-disciplinary chairs will work together to teach participating students in multi-disciplinary projects. These composed and specific educational tracks will be conducted under the supervision of the combined chairs, which we like to call a *bench*. A bench is illustrated in Figure 86, it is made up of several chairs and brands. In the coming decades such benches may form their own chairs. Moreover, because they are explicitly aimed at creating inter-disciplinary knowledge between brands, we would like to propose an additional function '*Nector*' for higher education.

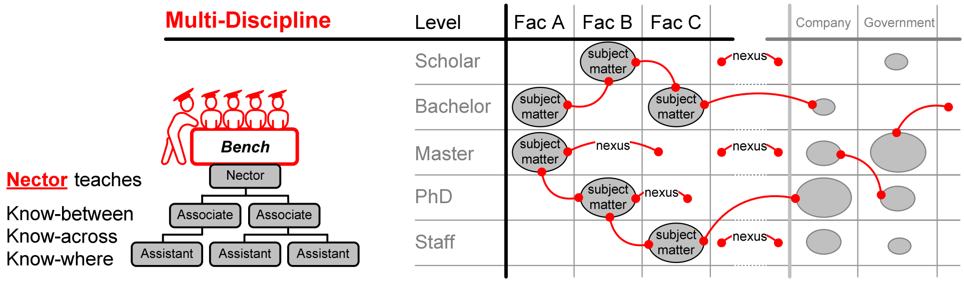


Figure 84: Benches are combined Chairs for Valorising Educational Projects by A.H.W. van der Zanden

Nector comes from the Latin word '*nectere*', which means to bind, to bond, to link. A *nexus* is an important connection between parts of a system or a group of things. Hence, we want to catch the interdisciplinary communication and activities with this word Nexus and professionals teaching them as Nector. Just as a professional chair for subject matter holds the expert functions Professor, Associate Professor and Assistant Professor, so would we like to propose the functions Nector, Associate Nector and Assistant Nector.
Nectors are interdisciplinary binders, scientifically specialised in communication and interaction for multi-disciplines, in adjusting design methodologies, vocabularies, ontologies, dimensioning, techniques, and many other interdependencies. Nectors are theorists for process-oriented linking of multi-disciplines, they are practitioners of valorisation projects and coaches for participating students, they publish approaches, technologies and outcomes, and valorise educational knowledge into products and services.

Key Principle 3 – Introduce curricula for interdisciplinary communication and interaction. Assign nectors, associate nectors and assistant nectors to teach and instruct students in proper interdisciplinary knowledge when participating in valorisation projects.

8.6 Valorisation Committee for Valorisation Projects

Referring to question j "how can a metric system be fit within higher education for both education and research output", posed in Section 3.2.2, we want to introduce a valorisation committee.

The university should organise a valorisation committee to assign credits to project initiation documents (PID) and project valorisation documents (PVD). Professional project leaders, team leaders, coaches and researchers, as depicted in Figure 85, will be required to cover many disciplines from universities, government and corporations, members of the committee will be assigned dependent of the project.

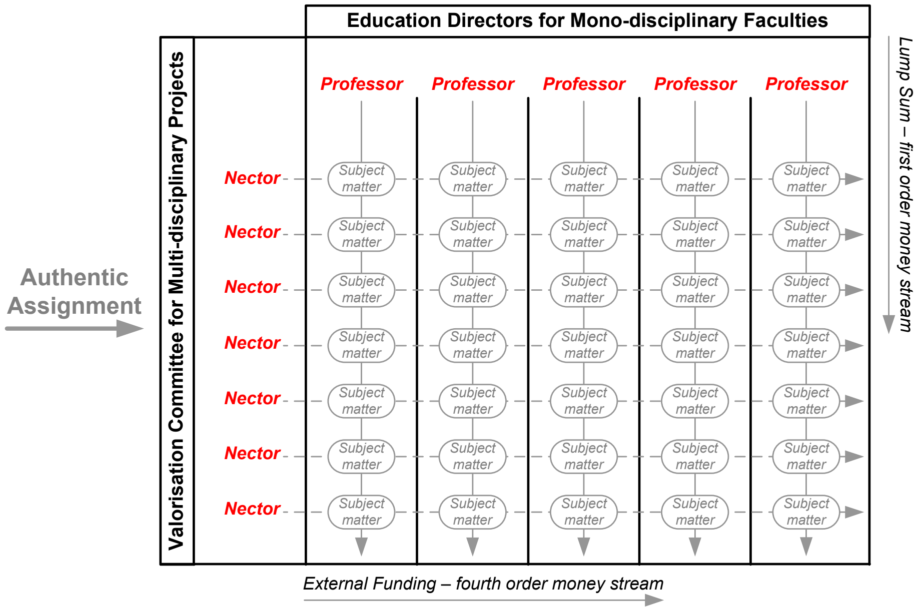


Figure 85: Mono-Disciplinary Faculties facilitate Multi-Disciplinary Educational Tracks by A.H.W. van der Zanden

The main objective of the valorisation committee is quality assurance, for the contents of the PID and its representation in credit points, for the decomposed project parts of the PVD, study credit points for students, level and terms, and valuation in credit points for the composers.

The components of the PID should be documented online in a backbone structure to provide a knowledge base for the project, the components of the PVD will be built on this backbone. In such way the online project structure archives the project parts, evolves to complete project descriptions, obtains assignments and when conducted also produces results from the students as creators and producers. It is necessary to work out an appropriate backbone structure for such project portals.

Key Principle 4 – Introduce a Valorisation Committee organisation structure to assess initiation (PID) and decomposition (PVD) documents and to assign appropriate credits. Work out an appropriate online documentation structure within portals for the valorisation projects.

8.7 RECRUITING AND RE-BONDING STUDENTS

Referring to question s "which educational setting can facilitate formal and informal learning situations", posed in Section 3.6.7, we want to introduce alma mater activities next to the learning processes.

Once a valorisation project is worked out, and the go ahead is agreed, an advertisement is placed to attract students to work on the project. Application rounds are organised to recruit students for the many mono- and multi-disciplinary project parts. If students meet the requirements for a project part, that is to say, they can demonstrate they have acquired the required subject credits, and they are motivated to join the project either as a scholar, bachelor, master or PhD student, then they may apply to work on an outlined task of a valorisation project.
Students will apply for projects that attract them and suit them, hence immersion, motivation, challenge, relevance and self-direction, as intrinsic drivers will be inherently present in the learning process (Veen & Vrakking, 2006), and because many disciplines will be brought together in a valorisation project, interaction between students and staff as human beings will be present as a worthy learning experience. Students will collect education credit points, join special multi-disciplinary project teams and aim at a well-structured output during a valorisation project. Students will be partners in creative design teams with disparate disciplines and obtain a project certificate. Students in this model are the social, intellectual, virtual and intangible capital of a university (Coleman, 1988) valorised by carrying out authentic multi-disciplinary education projects; *they represent the new money*. Third generation universities arrange conditions to promote valorisation and the money it can bring. Free time and free space for students to develop socially and to bond must not be reduced, not for economic reasons nor for reasons of efficiency. On the contrary, universities should nurture their students with social events to bond them to faculty, with community memberships, with authentic project pools, with buddy systems to bind them locally, and with meeting spaces on campus in, for instance, learning centres (Oblinger, 2006). Probably such a nurturing environment will attract students, but as counter-assignment the university will expect students to be dedicated and to work professionally when set to work in project teams to valorise projects.

Valorisation of education in such way considers the student to be a capital asset, not a customer who buys knowledge, but the student is a member of a university's community who sells knowledge. When students are acquainted with authentic projects during their university study period, they probably will be open to offering authentic projects to their, or another, university when they later have a job. *To sow strong bonds during a person's study years is to harvest valorisation projects during their professional years*. Such strong bonds help shape a university even when dealing with relatively short study terms such as those of exchange master students.

Key Principle 5 - Bond students to the university with alma mater activities, such as social programs, buddy programs, community programs, tailored learning and meeting spaces.

8.8 Support Organisation for Learning on Demand Practice and Technologies

Referring to question h "how higher education can take advantage of instant information access within the learning and working environment", posed in Section 3.1.4, we propose to organise capacity to design and support the learning on demand practice.

We have described the changes in the support organisation that will come when universities change their educational practices and its technologies, see Section 7.6. Considering today's developments, universities are on the edge of a digital era where both personalisation and mobility change the ways universities function. As far as initial learning is concerned, universities might take different strategies to implement teaching and learning practices and technology, but if an institution wants to take the vanguard position, it will have to organise support for new educational practices, appropriate knowledge of the learning-on-demand practice and technology is scarce and should be well organised. Multiple disciplines should be brought together and multi-disciplinary areas should be defined. This will touch the whole organisation of universities, Learning-on-demand as an educational practice needs to be implemented in the curricula and to be supported, the users need support with training, help desk and tutorials, and technologies used need experts to tailor applications, their organisation and practice, and 24*7 maintenance will be required to keep the systems up-and-running.

Using Gompertz's rate-of-change can help educational managers to play a positive and active role in the implementation of portals and repositories. Educational managers should act as they face change aspects when switching from using current educational technology to new forms. Such changes must not only be focussed on the new technology, special attention must be given to building capacity for using the appropriate pedagogies, which should be made, based on and enhanced, by the use of such educational technology. The switch should be made smoothly with the two technologies used in parallel operation during the changeover. Educational managers will need to direct the complex and probably unwanted switchover and convert the potential users of the new technologies, if it chooses to take a lead position: unwanted because the current staff at a university mastered the current situation, and be possibly, unwilling to change their position within the organisation, and complex because of the need to support continuing primary processes.

Key Principle 6 – Organise capacity in project teams to design the learning on demand practice. Appoint and train people, develop repositories, metadata learning materials, develop portals for interaction and search strategies, develop plans, scenarios and scripts, in programmes of at least 3 to 5 years.

8.9 Compose Appropriate Technology for Learning on Demand Practice

Educational technology designed to support learning-on-demand is not yet available in ready-to-install packages. Many technological developments currently on the market can be used within a compound system, however, these have to be connected in a structural way to compose a robust architecture. Open access repositories must be organised to hold many sorts of multimedia learning materials that have to be designed, valued, metadated and exposed. Proper procedures must be organised and automated, then interfaced with intelligent profiling, peer systems, social portals, interactive user interfaces and search algorithms.

We would advice educational management to address the innovators and early adopters of educational technology when changes must take place, no matter the technology, pedagogy, organisation or support. The diffusion theory makes clear that the adaptation of something new grows smoothly, maybe even in parallel with our derived Gompertz formula. Addressing the innovators and adopters may be done in pilot projects, however, for critical systems such pilot projects need terms of at least 3 to 5 years to decide on their value for an organisation. At least that is what we expect considering our empirical figures and critical mass. Moreover, to keep the diffusion going with little force, there is a need to focus on efficiency and ease of use when introducing new technologies.

Key Principle 7 – Organise the composition of technology for the learning on demand practice in collaborating project teams. Build pilot projects for periods of at least 3 to 5 years to create a sound and robust platform.

8.10 CONCLUSION FOR THE FACILITATING UNIVERSITY

Referring to question m "how higher education can unleash itself from the industrial chains as listed in Table 3", posed in Section 3.2.5, we want to advise a management package of 7 key principles to be discussed for execution.

Multi-disciplinary education tracks came into play once personalisation and computers made it possible to choose a number of elective courses within a curriculum. Bachelor-master and major-minor structures made this personalisation a student's commodity. First, only single courses were available, but a trend emerges for complete learning tracks to be provided at other universities. Given these choices, students opted to work in multi-disciplinary teams to realise real-life projects in urban areas, in developing countries, on projects for sustainable energy, recycling, environmental issues, etcetera. To date, participating in such projects often does not deliver education credit points. We think it is time to formalise credit procedures and arrange proper valuation for educational project efforts. Such projects need valorisation for students to obtain study credit points and valorisation for universities to obtain *'new money'*.

Embracing projects for the cause of good, and human well being, are the best advertisements for a university, presented on television, newspapers, Internet and in personal weblogs. Top universities do not only depend on quoted top researchers in special research areas and long-standing journal articles, they also depend on other's images of the institute. Such images value universities for society, which is an important asset of valorisation processes. Moreover, when valorisation of projects comes into focus in universities then society gains active steering power in universities, using valorisation projects society will be able to justify its influence on the research agenda of universities. Big companies should loose their ability to buy out patents that help the planet but kill their business, man must not stand beside nature and make use of the planet's resources as were it disposables. We are connected to all species on earth, we are nature, perhaps with a privileged position, but we are a link in the life cycle of planet earth, everything we do has its consequences or effects (Darwin, 1859; Gore, 2006; Lippe-Biesterfeld, 1995). Our consciousness of Planet Earth is becoming more positive, and one response is to move towards the third generation university with sustainability as its overarching characteristic.

A university that facilitates valorisation builds on emerging technologies, opens up learning materials for free use, collects income to conduct educational projects, aims at multi-disciplinary curricula and adapts its organisation structure to meet its needs and those of its learners and society. Such a facilitating university takes its first small steps out of the present second generation instruction factory paradigm, but it must take a giant step to move forward on its way to become a fully-fledged third generation university. Valorisation will take its place alongside education and research; it will become mainstream, but can only exist in direct interaction with mono-disciplined education and research processes.

We have collected seven key principles, related to trends we have observed in higher education. Addressing them and transposing them on a university's organisation will help higher education to gain an entrepreneurial state-of-mind, facilitate new pedagogies built on new technologies, help an institution to take a strong position in society, to organise response modes with external institutions and help universities to earn new money with students as producers. The seven key principles to position next generation higher education are:

- Key Principle 1 – Valorise education by delivering products and services for third parties with hard currency in return. Subsequently, introduce income for valorisation projects as a fourth-order money-stream.
- Key Principle 2 – Organise credit metrics for the intake of educational valorisation projects (Project Initiation Document) and their decomposition (Project Valorisation Document).
- Key Principle 3 – Introduce curricula for interdisciplinary communication and interaction. Assign nectors, associate nectors and assistant nectors to teach and instruct students in proper interdisciplinary knowledge when participating in valorisation projects.

- Key Principle 4 – Introduce a Valorisation Committee organisation structure to assess Initiation (PID) and decomposition (PVD) documents and to assign appropriate credits. Work out an appropriate online documentation structure within portals for the valorisation projects.
- Key Principle 5 - Bond students to the university with alma mater activities, such as social programs, buddy programs, community programs, tailored learning and meeting spaces.
- Key Principle 6 – Organise capacity in project teams to design the learning on demand practice. Appoint and train people, develop repositories, metadata learning materials, develop portals for interaction and search strategies, develop plans, scenarios and scripts, in programmes of at least 3 to 5 years.
- Key Principle 7 – Organise the composition of technology for learning-on-demand practice in collaborating project teams. Build pilot projects for periods of at least 3 to 5 years to create a sound and robust platform.

The Organisation for Economic Co-operation and Development states that in the future "working is learning" (OECD, 2000). Our seven key principles if followed will help universities to aim at a learning environment where learning and working are inseparable. It is not clear which developments influence higher education the most, but we do know from our findings that we can manipulate the rate-of-change for implementation of new technologies. Consequently, educational management has steering power over educational technology developments: install technologies, support them, build physical learning spaces (Oblinger, 2006) and let those artefacts do the job of appropriation and structuration (DeSanctis & Poole, 1994) of educational technologies within higher education. Future education will be flexible, will increasingly facilitate ways of personalisation and will stimulate multi-disciplinary collaboration between universities, corporations, government and other organisations.

9 BIBLIOGRAPHY

Afuah, A. (2002). *Innovation Management: Strategies, Implementation, and Profits* (2nd ed.). Oxford: Oxford University Press.

Alessi, S. M., & Trollip, S. R. (1991). *Computer-based Instruction* (2nd ed.). New Jersey: Prentice Hall.

Alexander, M. A. (2002). *The Kondratiev Cycle; A generational interpretation*. Lincoln: iUniverse.

Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2009). *Trends in Global Higher Education: Tracking an Academic Revolution*. Paris: UNESCO.

Aristoteles. (2005). *Ethica Nicomachea* (C. Hupperst & B. Poortman, Trans.). Budel: Damon.

Assendelft, M. M. v., Gessel, H. L. v., Molenaar, M. D., & Schaafsma, A. A. M. (1997). *Via Nova* (3rd ed.). Utrecht: Thieme Meulenhoff.

Atkins, D. E., Brown, J. S., & Hammond, A. L. (2007). *A Review of the Open Educational Resources (OER) Movement: Achievements, Challenges, and New Opportunities*. San Francisco: The William and Flora Hewlett Foundation.

Baets, W. (2001). Kennismanagement kan niet zonder (E-Learning); of is het andersom? [in Dutch]. *Management & Informatie, 9 (3)*, 33 - 39.

Bais, S. (2007). *De Sublieme Eenvoud van Relativiteit; Een Visuele Inleiding* (3 ed.). Amsterdam: Amsterdam University Press.

Bakas, A. (2009). *Microtrends Nederland*. Amsterdam: Scriptum.

Baldwin, R. B., & Chronister, J. L. (2001). *Teaching Without Tenure: Policies and Practices for a New Era*. Baltimore, Maryland: John Hopkins University Press.

Ball, P. (2004). *Critical Mass: How One Thing Leads to Another*. New York: Farrar, Straus and Giroux.

Baraniul, R. G. (2008). Challenges and Opportunities for the Open Education Movement: A Connexions Case Study. In T. Iiyoshi & V. Kumar (Eds.), *Opening Up Education: The Collective Advancement of Education through Open Technology, Open Content, and Open Knowledge* (pp. 229 - 246). London, England: The MIT Press.

Bass, F. M. (2004). A New Product Growth for Model Consumer Durables. *Management Science, 50*(12), 1825 - 1832.

Bass, L., Clements, P., & Kazman, R. (2003). *Software Architecture in Practice* (2nd ed.): Addison-Wesley Professional.

Bates, A. W. T. (2000). *Managing Technological Change; Strategies for college and university leaders* (1st ed.). San Fransisco, CA: Jossey-Bass Publishers.

Bell, M., Martin, G., & Clarke, T. (2004). Engaging in the future of e-learning: a scenarios-based approach. *Education + Training, 46*(6/7), 296 - 307.

Bellis, M. (2003a). ARPAnet - The First Internet. Retrieved Nov, 2009, from http://inventors.about.com/library/weekly/aa091598.htm

Bellis, M. (2003b). Inventors of the Modern Computer: The History of the Transistor. Retrieved Nov, 2009, from http://inventors.about.com/library/weekly/aa061698.htm

Berkhout, A. J., & Duin, P. A. v. d. (2007). New Ways of Innovation: an Application of the Cyclic Innovation Model to the Mobile Telecom Industry. *International Journal of Technology Management, 40*(4), 294 - 309.

Berkhout, G. (2005). Naar een ingrijpende herfomulering van de Lissabon-strategie [in Dutch]. *Holland Management Review* (99), 53 - 63.

Berners-Lee, T., Hendler, J., & Lassila, O. (2001). The Semantic Web [Electronic Version]. *Scientific American*.

Berniker, E., & Beard, J. W. (2003, May 13 - 15). *From Text to Images; Leveraging Bandwidth to Displace Alphabets with Iconic Scripts*. Paper presented at the 12th International Conference on Management of Technology, Nancy, France.

Berresford Ellis, P. (2003). *A Brief History Of The Celts*. London: Constable and Robinson

Bertalanffy, L. v. (1934). Untersuchungen über die Gesetzlichkeit des Wachstums. *Allgemeine Grundlagen der Theorie; mathematische und physiologische Gesetzlichkeiten des Wachstums bei Wassertieren. Arch. Entwicklungsmech, 13*, 613 - 652.

Block, P. (1987). *The Empowered Manager*: Jossey-Bass.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*. New York: Addison Wesley Publishing Company.

Boezerooy, P., Manderveld, J., Kluijfhout, E., & Ham, R. (2008). *Toekomstscenario's: De nieuwe digitale leer- en werkomgeving voor studenten en docenten in 2020* (No. OW.08.2367). Utrecht: SURF Foundation.

Bolman, L. G., & Deal, T. E. (1991). *Reframing Organizations; Artistry, Choice, and Leadership* (3rd ed.). San Francisco: Jossey-Bass.

Bradford, P., Porciello, M., Balkon, N., & Backus, D. (2007). The Blackboard Learning System: The Be All and End All in Educational Instruction. *Journal of Educational Technology Systems, 35*(3), 301 - 314.

Bradwell, P. (2009). *The Edgeless University: Why Higher Education must embrace Technology*. London: Demos.

Brennan, M., Funke, S., & Anderson, C. (2001). *Learning Content Management System: A New eLearning Market Segment Emerges* (bulletin). Framingham: IDC.

Bright, J. R. (1963). Opportunity and threat in technological change. *Harvard Business Review, 41*(6), pp. 76 - 86.

Brown, D. (2005). *Angels & Demons*. New York: Atria Books.

Brown, J. S. (2000). Growing up Digital; How the Web changes work, education, and the way people learn. *Change,*(March/April), 11 - 20.

Brown, J. S., & Duguid, P. (1996). Universities in the digital age. In *Information Age Anthology* (July/August 1996 ed., Vol. Change, pp. 15). Washington D.C.: Heldref Publications.

Bruijn, H. d. (2004). *Waarom is de wiskunde zo onwerkelijk*. Delft: Delft University Press.

Bruner, J. (2004). *Toward a Theory of Instruction*. London: Belknap Press.

Bryan, L. L., & Joyce, C. L. (2007). *Mobilizing Minds: Creating Wealth from Talent in the 21st Century* (1 ed.). New York: McGraw-Hill.

Buelens, H., Roosels, W., Wils, A., & Rentergem, L. v. (2002, 2002, Sep 2nd). *One Year e-Learning at the K.U. Leuven, an Examination of Log-Files*. Paper presented at the European Conference: The New Educational Benefits of ICT in Higher Education, Rotterdam.

Buie, E. (2005). Creative Thinkers wither with Age. *Times Educational Supplement*.

Cafolla, R. (2006). Project Merlot; Bringing Peer Review to Web-Based Educational Resources. *Journal of Technology and Teacher Education, 14*(2), 313 - 323.
Camall, C. A. (1995). *Managing Change in Organizations* (2nd ed.). London: Prentice Hall.
Cambridge University Press. (2001). Cambridge Online Dictionary. Retrieved Sep 5th, 2003
Capurro, R. (2004). Skeptical Knowledge Management. In H. C. Hobohm (Ed.), *Knowledge Management: Librarians taking up the Challenge* (Vol. 108, pp. 47 - 57). Munich: Saur.
Carayannis, E. G., & Wetter, J. (2004, Apr 3 - 5). *The Nature and Dynamics of Discontinuous versus Disruptive Innovations and the S-Curve*, 13th International Conference on Management of Technology.
Carneiro, R. (2007). Self-regulated learning: theoretical and empirical studies done in Portugal. In R. Carneiro, P. Lefrere & K. Steffens (Eds.), *Self-regulated Learning in Technology Enhanced Learning Environments: A European Review* (pp. 110 - 135). Aachen: Shaker Verlag.
Carr, D. K., & Hard, K. J. (1996). *Managing the Change Process; A Field Book for Change Agents, Consultants, Team Leaders, and Reengineering Managers*. New York: McGraw-Hill.
Caspers, W. (2007). Instaptoets en opfrisonderwijs aan de TU Delft 2006 (opzet, resultaten en analyse) [Electronic Version], 30. Retrieved Dec 14, 2007 from http://resonansgroepwiskunde.nl/opfrisonderwijs.pdf.
Castells, M. (1996). *The Rise of the Network Society, The Information Age; Economy, Society and Culture* (Vol. 1). Oxford, UK: Blackwell Publishing.
Castells, M. (1997a). *The End of the Milennium, The Information Age; Economy, Society and Culture* (Vol. 3). Oxford, UK: Blackwell Publishing.
Castells, M. (1997b). *The Power of Identity, The Information Age; Society and Culture* (Vol. 2). Oxford, UK: Blackwell Publishing.
Cattheeuw, C. (2005). *Als de muren konden spreken; schoolwandplaten en de geschiedenis van het Belgisch lager onderwijs*. Katholieke Universiteit Leuven, Leuven.
CERI. (2007). *Understanding the Brain; The Birth of a Learning Science*. Brussel: OECD.
Cherry, S. (2004). Edholm's Law of Bandwith: Telecommunications data rates are as predictable as Moore's Law. *IEEE Spectrum*, 58 - 59.
Christensen, C. M. (1997). *The Innovators Dilemma: When New Technologies Cause Great Firms to Fail*.
Clark, D. (2003a). *Evaluation of Learning* (White Paper). Brighton: Epic Group PLC.
Clark, D. (2003b). *M-learning* (White Paper). Brighton: Epic Group PLC.
Clark, D. (2003c). *Motivation in e-learning* (White Paper). Brighton: Epic Group PLC.
Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*(94:Supplement S95-S120).
Coleman, M., & Earley, P. (2004). *Leadership and Management in Education*. Oxford: Oxford University Press.
Colfer, E. (2001). *Artemis Fowl*. London: Viking Children's Books.
Collis, B. (1997). Implementing ICT in the faculty; letting a 1000 flowers bloom or managing change. In *De digitale leeromgeving* (pp. 121-136). Groningen: Wolters-Noordhoff.
Collis, B., & Gommer, E. M. (2001). *C@mpus 2005 - Scenarios for Future Learning Environments involving the University of Twente*. Enschede: University of Twente.
Collis, B., & Moonen, J. (2002). *Flexible Learning in a Digital World; Experiences and Expectations*. London: Kogan Page Limited.
Collis, B., & Pals, N. (2000). A Model for Predicting an Individual's Use of a Telematics Application for a Learning-Related Purpose. *International Journal of Educational Telecommunications, 6*(1), 63 - 103.
Collis, B., Wende, M. v. d., Boer, W. d., Boezerooy, P., & Gervedink, G. (2002). *Models of Technology and Change in Higher Education; An international comparative survey on the current and future use of ICT in Higher Education*. Enschede: CHEPS; Center for Higher Education Policy Studies.
Commissie Europese Gemeenschappen. (2000). *Het onderwijs van morgen uitdenken; De innovatie bevorderen met behulp van de nieuwe technologieën [in Dutch]* (Advisory report). Brussel: Commissie van de Europese Gemeenschappen.
Commission of the European Communities. (2005). *Towards a European Qualifications Framework for Lifelong Learning*. Brussels: European Community.
Compaine, B. M. (2001). *The Digital Divide: Facing a Crisis or Creating a Myth?* Massachusetts, USA: MIT Press.
Cross, J. (2006). *Informal Learning: Rediscovering the Natural Pathways That Inspire Innovation and Performance* Arkansas: Pfeiffer
Cross, J., & Hamilton, I. (2002). The DNA of e-learning. Retrieved Nov, 2009, from http://www.internettime.com/Learning/articles/DNA.pdf
Crowley, J. S. (2003). *Cognitive Vision Research Roadmap*. Bruxelles: ECVision.
Daale, H., & Asselt, R. v. (2007). *Voorkomen van Uitval en het Verhogen van Rendementen*. Enschede: LICA.
Darwin, C. (1859). *On the Origin of Species by Means of Natural Selection, or the Preservation of favoured Races in the Struggle for Life*. London: Murray.
Dave, R. H. (1975). *Developing and Writing Behavioural Objectives*: Educational Innovators Press.
Davidson, C. N., & Goldberg, D. T. (2009). *The Future of Learning Institutions in a Digital Age*. Cambridge, Massachusetts: John D. and Catherine T. MacArthur Foundation.
Deinum, J. F. (2003a). *Evaluatie Brainbox I; Implementatie en Knelpunten [in Dutch]* (Evaluation report). Groningen: Rijksuniversiteit Groningen.
Deinum, J. F. (2003b). *Evaluatie Brainbox II; Ervaringen van Docenten en Leerlingen [in Dutch]* (Evaluation report). Groningen: Rijksuniversiteit Groningen.
Deinum, J. F. (2003c). *Evaluatie Brainbox III; Statistieken en Eindconclusies [in Dutch]* (Evaluation report). Groningen: Rijksuniversiteit Groningen.
Delnooz, P. (1996). *Onderzoekspraktijken [in Dutch]*. Amsterdam: Boom.
DeSanctis, G., & Poole, M. S. (1994). Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory. *Organization Science, 5*(2), 139 - 145.
Dewey, J., & McDermott, J. J. (1981). *The Philosophy of John Dewey: Volume 1. The Structure of Experience. Volume 2: The Lived Experience* Chicago: University Of Chicago Press.
Dexter, S. L., Anderson, R. E., & Becker, H. J. (1999). Teachers' Views of Computers as Catalysts for Changes in Their Teaching Practice. *Journal of Research on Computing in Education, 31*(2), 221 - 239.
Dopper, S., & Ven, M. J. J. M. v. d. (2001, May 2-4, 2001). *ETUDE, educational online assessment system*. Paper presented at the International Seminar on Information and Communication Technologies in Engineering Education: "The impact of ICT on the curriculum".

Downer, R. G. H. (2004). Innovation in Undergraduate Teaching. In *Reinventing the Research University* (pp. 63). Paris: Economica.
Downes, S. (2005). Semantic Networks and Social Networks. *The Learning Organization Journal 12*(5), 411-417.
Drucker, P. F. (1994). The Age of Social Transformation. *The Atlantic Monthly, November*, 33.
Drucker, P. F. (1999). Beyond the Information Revolution. *Atlantic Monthly, Volume 284*(No 4), page 47-57.
Duin, A. H., Baer, L. L., & Starke-Meyerring, D. (2001). *Partnering in the Learning Marketspace. EDUCAUSE Leadership Strategies* (Vol. 4). Somerset: John Wiley & Sons.
Eco, U. (1999). *De Naam van de Roos & Naschrift* Amsterdam: Bakker.
Egenfeldt-Nielsen, S. (2005). *Beyond Edutainment: Exploring the Educational Potential of Computer Games.* Copenhagem: IT-University of Copenhagen.
Egenfeldt-Nielsen, S. (2006). Overview of research on the educational use of video games. *Digital kompetanse 1*(3), 184-213.
Eijnatten, F. M., van. (2003, Apr). *Chaordic Systems Thinking; Chaos and Complexity to Explain Human Perfomance Management.* Paper presented at the International Conference on Perfomance Measures, Benchmarking and Best Practices, University if Minho, Portugal.
Einstein, A. (1997). *Mijn Theorie; Over de Speciale en Algemene Relativiteitstheorie*: Het Spectrum.
Ellsworth, J. B. (2000). *Surviving Change; A Survey of Educational Change Models.* Washington DC: Association for Educational Communications & Technology
Ely, D. P. (1990). Conditions That Facilitate the Implementation of Educational Technology Innovations. *Journal of Research on Computing in Education, 23*(2), 298 - 305.
Ertmer, P. A., & Newby, T. J. (1993). Behaviorism, Cognitivism, Constructivism; Comparing Critical Features from an Instructional Design Perspective. *Perfomance Improvement Quartertly, 6*(4), 50 - 72.
Fabian, P., Veen, W., & Mühren, A. (2007, 6 - 8 Sep). *Finding a balance in blended learning with extra large student groups.* Paper presented at the 5th International Conference on Emerging e-Learning Technologies and Applications, Košice, Slovakia.
Falvo, D. A., & Johnson, B. F. (2007). The Use of Learning Management Systems in the United States. *TechTrends: Linking Research and Practice to Improve Learning, 51*(2), 40 - 45.
Ferren, A. S., Kennan, W. R., & Lerch, S. H. (2001). Reconciling Corporate and Academic Cultures. *Peer Review, 3*(3), 1 - 5.
Fisser, P. H. G. (2001). *Using Information and Communication Technology; A process of Change in higher Education.* Twente University Press, Enschede.
Foster, I., & Kesselman, C. (1998). *The Grid: Blueprint for a New Computing Infrastructure* San Fransisco: Morgan Kaufmann Publishers.
Foster, R. (1987). *Innovatie; de aanval is de beste verdediging (the attacker's advantage).* Utrecht: Veen.
Foster, R. N., & Kaplan, S. (2001). *Creative Destruction; Why Companies That Are Built to Last Underperform the Market - and How to Succesfully Transform Them*: Currency & Doubleday.
Frencken, H., Nedermeijer, J., Pilot, A., & Dam, I. t. (2002). *ICT in het hoger onderwijs; Stand van zaken.* Utrecht: Universiteit Utrecht (IVLOS).
Friedman, T. L. (2007). *The World is Flat 3.0* (3rd ed.). New York: Picador.
Fullan, M. G. (1999). *The New Meaning of Educational Change* (2nd ed.). New York: Teachers College Press.
Fullan, M. G., & Hargreaves, A. (1991). *What's Worth Fighting For? Working Together for Your School.* Washington DC: Education Research and Improvement.
Gabaldon, D. (1991). *Outlander.* New York: Bantam Dell.
Gaffin, J. C. (2007). *Internet Protocol 6.* New York: Nove Publishers.
Gagné, R. M. (1962). Military Training and Principles of Learning. *American Psychologist, 17*, 263 - 276.
Gagné, R. M., Briggs, L. J., & Wager, W. W. (2004). *Principles of Instructional Design* (4 ed.). Belmont: Wadsworth / Thomson Learning.
Galliers, R. D. (1992). *Researching Information Systems; Issues and Methods.* Oxford: Blackwell Science.
Garrison, D. R., & Anderson, T. (2003). *E-Learning in the 21st Century; A Framework for Research and Practice* (1st ed.). London: RoutledgeFalmer.
Gastel, L. v., Cuypers, H., Jonker, V., Vrie, E. v. d., & Zanden, A. H. W. v. d. (2007). *Eindrapport Nationale Kennisbank Basisvaardigheden Wiskunde.* Utrecht: ZuidamUithof Drukkerijen.
Gayle, B. M., Preiss, R. W., Burrell, N., & Allen, M. (2006). *Classroom Cummunication and Instructional Processes: Advances through Meta-Analysis.* Portland: Lawrence Erlbaum Associates.
Gayle, D. J., Tewarie, B., & White, A. Q. (2003). Governance in the Twenty-First-Century University; Approaches to Effective Leadership and Strategic Management. *ERIC Digest,* 6.
Gee, P. J. (2003). *What videogames have to teach us about learning and literacy.* New York: Palgrave Macmillan.
Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies* Sage Publications Ltd.
Gibson, D., Aldrich, C., & Prensky, M. (2006). *Games And Simulations in Online Learning: Research and Development Frameworks.* London: IGI Global
Giddens, A. (1984). *The Constitution of Society; Outline of the Theory of Structuration.* Berkeley, CA, USA: University of California Press.
Glaser, R. (1962). *Psychology and Instructional Technology; training research and education.* Pitssburgh: University of Pitssburgh Press.
Glaser, R. (2000). *Advances in instructional Psychology; Educational Design and Cognitive Science* Lawrence Erlbaum.
Glenn, J. C. (1994a). *The Futures Wheel.*
Glenn, J. C. (1994b). *Introduction to The Futures Research Methodology Series.*
Glenn, J. C., & Gordon, T. J. (1994). *Futures Research Methodology.*
Goedegebuure, L., & Vught, F. v. (1994). *Comparative policy studies in higher education.* Utrecht: Lemma.
Gompertz, B. (1825). On the Nature of the Function Expressive of the Law of Human Mortality, and on a New Mode of Determining the Value of Life Contingencies. *Philosophical Transactions of the Royal Society of London, 115*, 513 - 585.
Goodman, P. S. (2002a). Creating Organisational and Technology Change. In P. S. Goodman (Ed.), *Technology Enhanced Learning; Opportunities for Change* (pp. 153 - 179). mahwah, NJ: Laurence Erlbaum Associates.
Goodman, P. S. (2002b). *Technology Enhanced Learning; Opportunities for Change.* Mahwah, NJ: Laurence Erlbaum Associates.
Goodson, I. E., Knobel, M., Lankshear, C., & Mangan, J. M. (2002). *Cyber Spaces Social Spaces; Culture Clash in Computerized Classrooms.* New York: Palgrave Macmillan.

Goodyear, P. (2001). Psychological foundations for networked learning. In C. Steeples & C. Jones (Eds.), *Networked Learning: Perpectives and Issues* (pp. 49 - 75). London: Springer.
Gore, A. L. (2006). *An Unconvenient Truth*. New York: Rodale books.
Goud, A. (2001). E-Learning: verleden, heden en toekomst [in Dutch]. *Management & Informatie, 9 (3)*, 52 - 57.
Groot-Kormelink, J., Valkenburg, W. F. v., & Verberk, J. Q. J. C. (2009). *TU Delft OpenCourseWare: from repository to community*. Paper presented at the SEFI Engineering Education 2009, Rotterdam.
Gulledge, T. R., & Haszko, R. A. (2003). The Information Technology Enabled Organization:
A Major Social Transformation in the U.S.A. [Electronic Version]. *Management of Social Transformations*, *14* from http://www.unesco.org/most/gulled.htm.
Gurall, S. (2008). *Open Educational Resources Handbook for Educators*. Logan: Centre for Open and Sustainable Learning.
Hack, J. T. (2008). *Meaning-Making: A Key Pedagogical Paradigm for Schooling in the Third Milennium*. Australian Catholic University, Fitzroy, Australia.
Hall, G. E., & Hord, S. M. (1987). *Change in Schools Facilitating the Process*. New York: State University of New York Press
Hamel, J., Dufour, S., & Fortin, D. (1993). *Case Study Methods*. California: Sage Publications.
Harrow, A. (1972). *A taxonomy of psychomotor domain: a guide for developing behavioral objectives*. New York: McKay, David.
Havelock, R. G., & Zlotolow, S. (1995). *The Change Agent's Guide* (2nd ed.). Eaglewood Cliffs, NJ: Educational Technology Publications.
Hayes, J. (2007). *The Theory and Practice of Change Management: Second Edition* (2nd ed.). New York: Palgrave Maclillan.
Hegel, G. W. F. (1832). *Phänomenologie des Geistes*. Berlin: Duncker und Humblot.
Hijazi, S. (2004, Jun 6 - 10). *Too Much Information - Too Much Apprehesion*. Paper presented at the ASCUE Conference.
Hippel, E. v. (2005). *Democratizing Innovation*. Cambridge, Massachusetts: The MIT Press.
Hoeven, M. v. d. (2005). What will educational leaders be leading in 2025? : Ministry of Education, Culture and Science.
Huijssoon, B., Tooren, M. v., & Groenewegen, P. (2007). *Zakboek Tweede Fase*. Den Haag: Tweede Fase Adviespunt.
Hyde, D. (2008). Sorites paradox [Electronic Version]. *Stanford Encyclopedia of Philosophy* from http://plato.stanford.edu/archives/fall2008/entries/sorites-paradox/.
Iiyoshi, T., & Kumar, V. (2008). *Opening Up Education: The Collective Advancement of Education through Open Technology, Open Content, and Open Knowledge*. London, England: The MIT Press.
Ikenberry, S. O. (1999). The University and the Information Age. In W. Z. Hirsch & L. E. Weber (Eds.), *Challenges facing Higher Education at the Millennium*. Phoenix, Arizona: Oryx Press.
Inspiral. (1994). A comprehensive list of Virtual Learning Environment systems and their suppliers. Retrieved Fri 19th, 2004, from http://inspiral.cdlr.strath.ac.uk/resources/toolssystems.html
Jones, C. (2002, 2002, Dec 6 - 8). *Situation. Learning and Design; Contexts for Educational Use of Computer Networks*. Paper presented at the Ascilite 2002, Auckland, New Zealand.
Jung, C. G. (1995). *Archetype en Onbewuste* (P. d. Vries, Trans. 3rd ed. Vol. 2). Rotterdam: Lemniscaat.
Kant, I. (1787). *Kritik der reinen Vernunft* (2 ed.). Riga: Johann Friedich Hartknoch.
Kant, I. (2004). *Kritiek van de zuivere rede* (J. Veenbaas & W. Visser, Trans.). Amsterdam: Boom.
Kant, I. (2006). *Kritiek van de praktische rede* (J. Veenbaas & W. Visser, Trans.). Amsterdam: Boom.
Katzy, B. (2004, Apr 3 - 5). *Integrating Research Methodologies in Management of Technology*. Paper presented at the 13th International Conference on Management of Technology, Washington, USA.
Kebritchi, M., & Hirume, A. (2008). Examining the pedagogical foundations of modern educational computer games. *Computers & Education 51*, 1729-1743.
Kezar, A. J. (2001). *Understanding and Facilitating Change in Higher Education in the 21st Century* (Vol. 28). New York: John Wiley & Sons.
Khader, M., & Barnes, W. E. (1999). *Telecommunications Systems and Technology*. San Francisco: Prentice Hall.
Khandelwal, V. K., & Ferguson, J. R. (1999). *Critical Success Factors (CSFs) and the Growth of IT in Selected Geographic Regions*. Paper presented at the 32nd Hawaii International Conference on System Sciences, Hawaii.
Kim, D., Gibbs, M., & Decker, B. (2008). *Unified Communications Solutions: A Practical Business and Technology Approach*. Nelson: Nortel Press.
Kirsh, D. (2001). A Few Thoughts on Cognitive Overload. *Intellectica, 30*(1), 19 - 51.
Kommers, P. A. M. (2005). *De les begint: mobieltjes aan!* , Fontys Hogescholen, Sittard.
Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1999). *Taxonomy of Educational Objectives; the Classification of Educational Goals. Handbook II: Affective Domain*. New York: Longman Pub Group.
Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*. Chicago: University of Chicago.
Kurzweil, R. (1999). *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*. New York: Viking Adult.
Lakatos, I., & Musgrave, A. (1970). *Criticism and the Growth of Knowledge*. Cambridge: Cambridge University Press.
Lansink, A. j. (2001). E-Learning: een nieuw instrument om klanten te bereiken [in Dutch]. *Management & Informatie, 9 (3)*, 13 - 23.
Laurillard, D. (2002). *Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies* (2nd ed.). London: RoutledgeFalmer.
Ledford, B. R., & Sleeman, P. (2002). *Instructional Design: System Strategies*: Information Age Publishing.
Leezenberg, M., & Vries, G. d. (2004). *Wetenschapsfilosofie voor Geesteswetenschappen* (4th ed.). Amsterdam: Amsterdam University Press
LeGrew, D. (1995). *Global knowledge: Superhighway or supergridlock? Applications of Media and Technology in Higher Education*. Chiba, Japan: National Institute of Multimedia Education, Japan.
Leigh, D. (1998). A brief History of Instructional Design. Retrieved Jun 29, 2007, from http://www.pignc-ispi.com/articles/education/brief%20history.htm
Lekanne Deprez, F., & Tissen, R. (2002). *Zero Space; Moving Beyond Organizational Limits*. San Francisco: Berret-Koehler Publishers, Inc.
Lemstra, W. (2006). *The Internet bubble; and the impact on the development path of the telecommunication sector*. Eemnes: Industry-Insights BV.
Levy, A., & Merry, U. (1986). *Organizational Transformation; Approaches, Strategies, Theories*. New York: Praeger.
Ligthart, A., Graave, J., & Rooij, R. d. (2005). *Service-Oriented Architecture, Een praktische leidraad voor invoering*: Socrates. Academic Service.
Lintsen, H. W. (1992). *Geschiedenis van de techniek in Nederland. Techniek en Modernisering Landbouw en Voeding* (Vol. 1). Zutphen: Walburg Pers.

Lintsen, H. W. (1993a). *Geschiedenis van de techniek in Nederland. Delfstoffen, machine- en scheepsbouw. Stoom. Chemie. Telegrafie en telefonie* (Vol. 4). Zutphen: Walburg Pers.
Lintsen, H. W. (1993b). *Geschiedenis van de techniek in Nederland. Gezondheid en openbare hygiëne. Waterstaat en infrastructuur. Pepier, druk en communicatie* (Vol. 2). Zutphen: Walburg Pers.
Lintsen, H. W. (1993c). *Geschiedenis van de techniek in Nederland. Textiel. Gas, licht en elektriciteit. Bouw* (Vol. 3). Zutphen: Walburg Pers.
Lintsen, H. W. (1994a). *Geschiedenis van de techniek in Nederland. Techniek en samenleving* (Vol. 6). Zutphen: Walburg Pers.
Lintsen, H. W. (1994b). *Geschiedenis van de techniek in Nederland. Techniek, beroep en praktijk* (Vol. 5). Zutphen: Walburg Pers.
Lippe-Biesterfeld, I. v. (1995). *Dialoog met de Natuur*. Deventer: Ankh-Hermes BV.
Lodge, D. (2007). Umberto Eco; The Name of the Rose. In *The Year of Henry James* (pp. 246 - 273). London: Penguin Books.
Lorenz, L. L. (2004, Apr 3 - 5). *Holon - A Unit of Analysis in the Theory of Technology*. Paper presented at the 13th International Association Management of Technology, Washington, USA.
Lowyck, J. (2001). E-Learning: Het verschil tussen opleiden en leren [in Dutch]. *Management & Informatie, 9 (3)*, 24 - 32.
Lubbe, J. C. A. v. d., & Zoest, A. J. A. v. (1997a). Het semiotisch instrumentarium. In J. C. A. v. d. Lubbe & A. J. A. v. Zoest (Eds.), *Teken en Betekenis* (pp. 9 - 25). Haarlem: Aramith.
Lubbe, J. C. A. v. d., & Zoest, A. J. A. v. (1997b). *Teken en Betekenis*. Haarlem: Aramith.
Lundgreen, P. (1990). Engineering education in Europe and the USA, 1750 - 1930. The rise to dominance of school culture and the engineering professions. *Annals of Science, 47 (1)*, 33 - 75.
Machiavelli, N. (1513). *Il Principe. De Heerser [in Dutch]* (F. v. Dooren, Trans. 13e druk ed.). Amsterdam: Athenaeum-Polak & Van Gennep.
Mager, R. (1997). *Preparing Instructional Objectives: A Critical Tool in the Development of Effective Instruction* (3 ed.): Center for Effective Performance.
Mahajan, V., Muller, E., & Bass, F. M. (1995). Diffusion of New Products: Empirical Generalizations and Managerial Uses *Marketing Science, 14*(3), G79 - G88.
Marx, K. (1890). *Das Kapital; Kritik der politischen Oekonomie* (I. LipSchits, Trans. 4 ed. Vol. 1). Hamburg: Otto Meisner.
Marx, K., & Engels, F. (1844). *Die heilige Familie oder Kritik der kritischen Kritik*. Berlin: Dietz Verlag.
Marx, K., & Engels, F. (1848). *Manifest der Kommunistischen Partei*. London.
Maslow, A. (1943). A Theory of Human Motivation. *Psychological Review, 50*, 370 - 396.
Masters, J. (1995). The History of Action Research. *Action Research Electronic Reader*, 1 - 9.
Melville, D. (2009). *Higher Education in a Web 2.0 World*. Bristol: Committee of Inquiry into the Changing Learner Experience.
Miles, M. B., & Huberman, A. M. (1994). *Quality Data Analysis; An Expanded Sourcebook* (2nd ed.). Thousand Oaks, California: Sage publications.
Mohrman, K., Ma, W., & Baker, D. (2008). The Research University in Transition; The Emerging Global Model. *International Association of Universities, Higher Education Policy*(21), 5 - 27.
Moonen, J. (2003). Simplified Return-On-Investment; a new approach. *Interactive Learning Environment, 11*(2), 147 - 165.
Moore, A. (2000). *Teaching and Learning: Pedagogy, Curriculum and Culture*. London: Routledge Falmer.
Mora, J.-G. (2007). *Rates of Return and Funding Models in Europe*. Valencia, Spain: Valencia University of Technology.
Morgan, G. (1986). *Images of Organization*. Newbury Park, CA: Sage Publications.
Morris, T. (1999). *Philosophy for Dummies* (P. E. Benelux, Trans.). Foster City, California: Hungry Minds.
Morrison, G. R., Ross, S. M., & Kemp, J. E. (2006). *Designing Effective Instruction* (5 ed.). New York: John Wiley & sons.
Motteram, G. (2006). Blended Education and the Transformation: A long-term Case Study in Postgraduate Higher Education. *British Journal of Educational Technology, 37*(1), 17 - 30.
Mulligan, J. (1990). *The Personal Managment Handbook*. Helmond: Rostrum.
Mutsaers, E.-J., Zee, H. T. M. v. d., & Giertz, H. (1998). The evolution of information technology. *Information Management & Computer Security, 6*(3), 115 - 126.
National Library. (2006). *Nederlandse Basisclassificatie* (4 ed.). The Hague: National Library of the Netherlands.
Nauta, D. (1997). Werken aan de informatiemaatschappij. In J. v. d. Lubbe & A. v. Zoest (Eds.), *Teken en Betekenis* (pp. 195 - 214). Haarlem: Aramith.
New Media Consortium, & Educause. (2008). *The Horizon Report*. Stanford: New Media Consortium.
Nieuwenhuis, M. A. (2003). *The Art of Management; Strategy and Structure* (2 ed. Vol. 1). Apeldoorn.
Nolan, R. L. (2000). Information Technology Management since 1960. In A. D. Chandler & J. W. Cortoda (Eds.), *A Nation Transformed by Information; How Information has shaped the United States from Colonial Times to the present* (pp. 217 - 256). Oxford: Oxford University Press.
Nolan, R. L., & Croson, D. C. (1995). *Creative Destruction: A Six-Stage Process for Transforming the Organization*. Boston, Massachusetts: Harvard Business School Press.
Nolan, R. L., Croson, D. C., & Seger, K. N. (1992). The Stages Theory: A Framework for IT Adoption and Organizational Learning. In *America's Information Technology Agenda*. Cambridge: John F. Kennedy School of Government.
Nolan, R. L., & Gibson, C. F. (1974). Managing the Four Stages of EDP Growth. *Harvard Business School, 52 (1)*, 76 - 88.
Oberg, J. (1999). Why the Mars Probe Went off Course. *IEEE Spectrum, 99*, 34 - 39.
Oblinger, D. G. (2006). *Learning Spaces*. Washington, DC: Educause.
Oblinger, D. G., & Oblinger, J. L. (2005). *Educating the Net Generation*. Washington, DC: Educause.
OECD. (2000). *Knowledge Management in the Learning Society; Education and Skills*. Paris: Organisation for Economic Co-operation and Development Publications.
OECD. (2001). Scenarios for the Future of Schooling. In *What Schools for the Future?* (pp. 252). Brussel.
Office in Technology Assessment. (1991). *U.S. Workforce Distribution in Agrarian, Industrial and Information Economics*. Washington DC.
Ollman, B. (1998). *Alienation; Marx's Conception of Man in Capitalist Society*. Cambridge: University Press.
Oosterbaan, W. (2009). Maak wetenschappelijke publicaties openbaar. *NRC handelsblad*.
Paulsen, M. F. (1995). The Online Report on Pedagogical Techniques for Computer-Mediated Communication. Retrieved Jan 30th, 2004, from http://home.nettskolen.nki.no/~morten/cmcped/litrev.html
Pavlov, I. P. (1927). *Conditioned Reflexes; An Investigation of the Psychological Activity of the Cerebral Cortex* (G. V. Anrep, Trans.).
Pederson, O., & North, R. (2003). *The First Universities; Studium Generale and the Origins of University Education in Europe*. Cambridge: Cambridge University Press.
Pedro, F. (2006). *The New Millennium Learners: Challenging our Views on ICT and Learning*. Bruxelles: OECD-CERI.

Perez, C. (2002). *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages* Cheltenham: Edward Elgar Publishing Limited.
Pershing, J. A. (2006). *Handbook of Human Performance Technology* (3rd ed.). San Francisco: Pfeiffer.
Piaget, J., & Inhelder, B. (1969). *The Psychology of the Child*. New York: Basic Books.
Plasterk, R. H. A. (2007). *Het Hoogste Goed; Strategische agenda voor het hoger onderwijs-, onderzoek- en wetenschapsbeleid*. Retrieved. from http://www.minocw.nl/documenten/52930.pdf.
Poel, H. v. d. (2002). *Tijd voor Vrijheid*. Amsterdam: Boom.
Popper, K. R. (1988). *De groei van kennis. Hoofdstukken uit Conjectures and Refutations; The Growth of Scientific Knowledge*. Meppel: Boom.
Popper, K. R. (2002). *The Logic of Scientific Discovery*: Routledge.
Porter, M. E. (1985, 1998). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press.
Prahalad, C. K., & Krishnan, M. S. (2008). *The New Age of Innovation: Driving Cocreated Value Through Global Networks*. New York: McGraw-Hill.
Prensky, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon, 9*(5), 1-2.
Prestoungrange, G., Sandelands, E., & Reare, R. (2000). *The Virtual Learning Organization: Learning at the Corporate University Workplace Campus*. New York: Continuum International Publishing Group.
Prometeus. (2001). *Knowledge Management in Corporates and SMEs Principles and Case studies* (Advisory report): Prometeus.
Quinn, B. (2007). Mobile phones 'dumbing down brain power'. *Telegraph.co.uk*.
Reigeluth, C. M. (1999). *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (Vol. 2). New York: Lawrence Erlbaum Associates.
Reigeluth, C. M., & Garfinkle, R. J. (1994). *Systemic Change in Education*. Eaglewood Cliffs, NJ: Educational Technology Publications.
Ridder, W. J. (2006). *Managing Breakthrough Innovations*. Enschede: Unversity of Twente.
Rogers, C., & Farson, R. E. (1987). Active Listening. In R. G. Newman, M. A. Danziger & M. Cohen (Eds.), *Communication in Business Today*. Washington: Health and Company.
Rogers, E. M. (2003). *Diffusion of Innovation* (5th ed.). New York: Free Press.
Roodenburg, R. (2007). *Een Kwestie van Tijd*. Schiedam: Loop-Doctor.
Rosenberg, M. J. (2001). *E-Learning; Strategies for Delivering Knowledge in the Digital Age*. New York: McGraw-Hill.
Rossett, A. (2002). *The ASTD E-Learning Handbook*. New York: McGraw-Hill.
Rousseau, J. J. (1762). *Du contract social; ou principes du droit politique*. Amsterdam: Chez Marc - Michel Rey.
Rowley, D. J., Lujan, H. D., & Dolence, M. G. (1998). The Faculty, Facilities, and Administration of the Future. In *Strategic Choices for the Academy: How Demand for Lifelong Learning Will Re-Create Higher Education* (1 ed., pp. 336). San Francisco: Jossey-Bass.
Rowling, J. K. (2005). *Harry Potter and the Half-blood Prince*. London: Bloomsbury.
Rushkoff, D. (1999). *Playing the future: What we can learn from digital kids*. New York: Riverhead Books.
Rutgers, M. R. (1993). *Tussen Fragmentatie en Integratie; de bestuurskunde als kennisintegrerende wetenschap*. Delft: Eburon.
Sainsbury of Turville, L. (2007). *The Race to the Top; A Review of Government's Science and Innovation Policies*. London: HM Treasury.
Salmi, J. (2009). *The Challenge of Establishing World-Class Universities*. Washington: The World Bank.
Sanderson, B. (2005). *Elantris*. New York: Tom Doherty Associates.
Sartre, J.-P. (1943). *L'Être et le néant : Essai d'ontologie phénoménologique*. Paris: Gallimard.
Schaller, B. (1996). Moore's Law: The Benchmark of Progress in Semiconductor Electronics. Retrieved Nov, 2009, from http://research.microsoft.com/~gray/Moore_Law.html
Schein, E. H. (1985). *Organizational Culture and Leadership' A dynamic View* (3rd ed.). San Francisco: Jossey Bass.
Schumpeter, J. A. (1939). *Business Cycles: A theoretical, historical and statistical analysis of the Capitalist process*. New York: McGraw-Hill.
Schuyt, K. (1997). Tekens en betekenis in het sociale leven. In J. v. d. Lubbe & A. v. Zoest (Eds.), *Teken en Betekenis* (pp. 156 - 172). Haarlem: Aramith.
Senn, J. A. (2003). *Information Technology: Principles, Practices, and Opportunities* (3rd ed.): Prentice Hall.
Shuell, T. J. (1990). Phases of Meaningful Learning. *Review of Educational Research, 60*(4), 531 - 547.
Siemens, G. (2005). Connectivism; A Learning Theory for the Digital Age. *International Journal of Instructional Technology and Distance Learning, 2*(1), 8.
Sitskoorn, m. (2006). *Het Maakbare Brein*. Amsterdam: Bert Bakker.
Sjoer, E., Jacobs, F., Jong, K. d., & Veeningen, C. (2007). *Project Leven Lang Leren* (Advisory). Delft: E-merge.
Skinner, B. F. (1947). Superstition in the Pigeon. *Journal of Experimental Psychology*(38), 168 - 172.
Skinner, B. F. (1950). Are Theories of Learning Necessary? *Psychological Review*(57), 193 - 216.
Slavin, R. E. (2005). *Educational Psychology: Theory and Practice*. New York: Allyn & Bacon.
Smith, G. G., & Hermann, K. (2007). Front-Stage and Back-Stage in Hybrid E-Learning Face-to-Face Courses. *International Journal of E-Learning, 6*(3), 455 - 474.
Smith, M. K. (2002). Jerome S. Bruner and the process of education, *the encyclopedia of informal education*. Retrieved Nov, 2009, from http://www.infed.org/thinkers/bruner.htm
Spector, J. M. (2001). An Overview of Progress and Problems in Educational Technology. *Interactive Educational Multimedia, Number 3*, pp. 27-37.
Stake, R. E. (1995). *The Art of Case Study Research*. California: Sage Publisher.
Steeples, C., & Jones, C. (2001). *Networked Learning: Perspectives and Issues*. London: Springer Verlag.
Stevenson, J. (2003, 2003, Dec 5th). *Using E-learning at Work - The Theory and the Reality*. Paper presented at the Educa Online Berlin: 9th International Conference on Technology Supported Learning and Training, Berlin.
Suppes, P. (1972). *Computer Assisted Instruction*. New York: Academic Press Inc.
Surowiecki, J. (2004). *The Wisdom of Crowds*. New York: Random House.
Swanborn, P. G. (1987). *Methoden van sociaal-wetenschappelijk onderzoek* (2nd edition ed.). Meppel: Boom.
Taniar, D., & Rahayu, J. W. (2006). *Web semantics and ontology* Hershey: Idea Group Inc
Tapscott, D. (1997). *Growing Up Digital: The Rise of the Net Generation*. New York: Mcgraw-Hill.
Tartwijk, J. v., Driessen, E., Hoeberigs, B., Kösters, J., Ritzen, M., Stokking, K., & Vleuten, C. v. d. (2003). *Werken met een elektronisch portfolio [in Dutch]*. Groningen: Wolters-Noordhoff.
Telematica Institute. (2001a). E-Learning: de technologie in ontwikkeling [in Dutch]. *Management & Informatie, 9 (3)*, 40 - 49.

Telematica Institute. (2001b). E-Learning: voordelen en kansen op organisatieniveau [in Dutch]. *Management & Informatie, 9 (3)*, 4 - 12.
Tellis, W. (1997, Jul). Introduction to Case Study. *The Qualitative Report, 3*.
Tempelaar, D. (2007). *Expectancy-value based achievement motivations and their role in student learning*. Maastricht: Datawyse.
Tempelman, C. J. J. (2009). *Evaluatieonderzoek Blackboard* (Evaluation No. 19611). Groningen: Hanzehogeschool Groningen.
Tewoldeberhan, T. W. (2005). *Gaining insight into business networks: a simulation based support environment to improve process orchestration*. Utrecht: Febodruk.
Tolkien, J. R. R. (1954). *The Lord of the Rings* (Single Volume ed.). Hong Kong: Harper Collins Publishers.
TU Delft. (2003). *Focus op Onderwijs*. Delft: Delft University of Technology.
Tyler, R. W. (1976). *Perspectives on American education : reflections on the past ... challenges for the future*. Chicago: Science Research Associates.
Upcraft, M. L., Gardner, J., N., & Barefoot, B. O. (2004). *Challenging and Supporting the First-Year Student: A Handbook for Improving the First Year of College* San Francisco: Jossey-Bass.
Vaughan, N. (2007). Perspectives on Blended Learning in Higher Education. *International Journal on E-learning, 6*(1), 81 - 94.
Veen, W. (1994). *Computer-assisted Teachers; The teacher's role in the implementation of computers in the instructional practice [in Dutch]*. Utrecht: University of Utrecht.
Veen, W. (2000). *Flexibel onderwijs voor nieuwe generaties studerenden [in Dutch]*. Delft: Delft University of Technology.
Veen, W., & Jacobs, F. (2005). *Leren van Jongeren: een literatuuronderzoek naar nieuwe geletterdheid*. Utrecht: Stichting SURF.
Veen, W., Valkenburg, W. F. v., Santema, S. C., & Genang, R. (2002, 2002/10/15-19). *The New Generation Working Force: The Homo Zappiens*. Paper presented at the E-Learning 2002 in Corporate, Government, Healthcare and Higher Education, Montreal, Canada.
Veen, W., & Vrakking, B. (2006). *Homo Zappiens: Growing up in a Digital Age*. London: Network Continuum Education.
Ven, M. J. J. M. v. d. (1998). *Instructies bij Computersimulaties in het Technisch Onderwijs*. Delft: Delft University Press.
Verbrugge, A., & Verbrugge-Breeuwsma, M. (2006). *Manifest: Beter Onderwijs Nederland*.Unpublished manuscript, Amsterdam.
Verhulst, P. F. (1845). Recherches Mathematiques sur La Loi D'Accroissement de la Population (Mathematical Researches into the Law of Population Growth In). *Nouveaux Memoires de l'Academie Royale des Sciences et Belles-Lettres de Bruxelles, 18*(1), 1 - 45.
Vogt, M. (2005). *Dumonts Handbuch Philosophie* (B. Wiegers, Trans. 3 ed.). Keulen: Dumont monte Verlag.
Vossensteyn, H. (2007). The Case of the Netherlands. In J.-G. Mora (Ed.), *Rates of Return and Funding Models in Europe* (pp. 107). Valencia, Spain: Valencia University of Technology.
Vredeveldt, E. (1997). *Standaardisatie Kantoor Automatisering [in Dutch]* (Advisory report). Delft: Delft University of Technology.
Vrie, E. v. d., & Jonker, V. (2007). De huidige praktijk van de aansluiting wiskunde havo /vwo naar hbo/wo. In *Nationale Kennisbank Basisvaardigheden Wiskunde* (pp. 12). Utrecht: SURF Foundation.
Vries, P. d. (2005). *An Analysis Framework Approach for Managing Corporate E-Learning Development*. Twente: Universiteit Twente.
Watson, J. B. (1913). Psychology as the Behaviorist views it. *Psychological Review*(20), 158 - 177.
Weber, L. E., & Duderstadt, J. J. (2004). *Reinventing the Research University*. Paris: Economica.
Weber, L. E., & Zgaga, P. (2004). Reinventing the European Higher Education and Research Sector. In *Reinventing the Research University* (pp. 29). Paris: Economica.
Wende, M. v. d. (2001). The International Dimension in National Higher Education Policies: what has changed in Europe in the last five years? *European Journal of Education, 36*(4).
Wikipedia. (2007). History of European Research Universities.
Wilterdink, N., & Heerikhuizen, B. v. (2003). *Samenlevingen; Een verkenning van het terrein van de sociologie* (5th ed.). Groningen: Wolters Noordhof.
Wissema, J. G. (2005). *Technostarters en de Derde Generatie Universiteit [in Dutch]*. Delft: DUP Satellite.
Witten, I. H., & Frank, E. (2005). *Data Mining; Practical Machine Learning Tools and Techniques* (2nd ed.). Amsterdam: Morgan Kaufman.
Wolf, H. d. (1998). *Toekomstgericht onderwijs en het gebruik van infomatie- en communicatietechnologie; hoe te komen tot verantwoorde keuzen. [in Dutch]*. Heerlen: Samsom.
Wolf, M. J. P., & Perron, B. (2003). *The Video Game Theory Reader*. New York: Routledge.
Wunderlich, S., & Khalil, T. (2004, Apr 3 - 5). *Introducing Technology Timeline Interpretation to Technology Diffusion and Maturity Analysis as applied to different Industrial Sectors*. Paper presented at the 13th International Conference on Management of Technology, Washington, USA.
Wyk, R. J., van. (2004). *Technology, A Unifying Code; A Simple and Coherent View of Technology*. Cape Town: Stage Media Group.
Yerkes, R. M., & Morgulis, S. (1909). The Method of Pavlov in Animal Psychology. *The Psychological Bulletin*(6), 257 - 273.
Yin, R. K. (1994). *Case study Research; design and methods* (2nd ed. Vol. 5). London: Sage Publications.
Yin, R. K. (2002). *Case study Research; design and methods* (3rd ed. Vol. 5). London: Sage Publications.
Zaltman, G., & Duncan, R. (1977). *Strategies for Planned Change*. Hoboken: John Wiley & Sons.
Zanden, A. H. W. v. d. (2008). *ICT in het Onderwijs 2008* (Case Study). Delft: Delft Institute of Technology.
Zanden, A. H. W. v. d., Booms, P., Huizer, C. G., & Pelt, K. v. (1996). *Modernisering Ondersteunende Diensten: Onze visie gezien vanuit de Informatie Technologie en Electronica discipline [in Dutch]* (Advisory report). Delft: Delft University of Technology.
Zanden, A. H. W. v. d., & Cuypers, H. (2007). Wizmo.nl. In V. Jonker (Ed.), *Eindrapport Nationale Kennisbank Basisvaardigheden Wiskunde* (pp. 20). Utrecht: ZuidamUithof Drukkerijen.
Zanden, A. H. W. v. d., & Veen, W. (2003a, Dec 4 - 6). *Implementing a Corporate ICT in Education Policy: A Two-Fold Approach Aiming At Educational Innovation and Infrastructural Sustainability*. Paper presented at the Educa Online Berlin: 9th International Conference on Technology Supported Learning and Training, Berlin.
Zanden, A. H. W. v. d., & Veen, W. (2003b, May 13 - 15). *Standardisation of the Information Infrastructure at Delft University of Technology*. Paper presented at the 12th International Conference on Management of Technology, Nancy, France.
Zee, H. T. M. v. d., & Koot, W. J. D. (1989). I/T-assessment; een kwalitatieve en kwantitatieve evaluatie van de informatieverzorging vanuit een strategisch perspectief [in Dutch]. *Informatie, 31 (11)*, 837 - 851.

10 Summary

The Facilitating University

Positioning Next Generation Educational Technology

An overview of our study is presented in the conceptual framework given in Figure 1. The literature search and theoretical framework at the top were ongoing activities undertaken to answer the research questions presented at the left. The outcomes of the three research sub questions are given in terms at the bottom of the picture. Answer A was derived from literature, answer B was derived from an explorative and qualitative empirical test case and a quantitative study of 289 Blackboard virtual learning environments, and answer C was composed out of collected trends that we assume will shape the future.

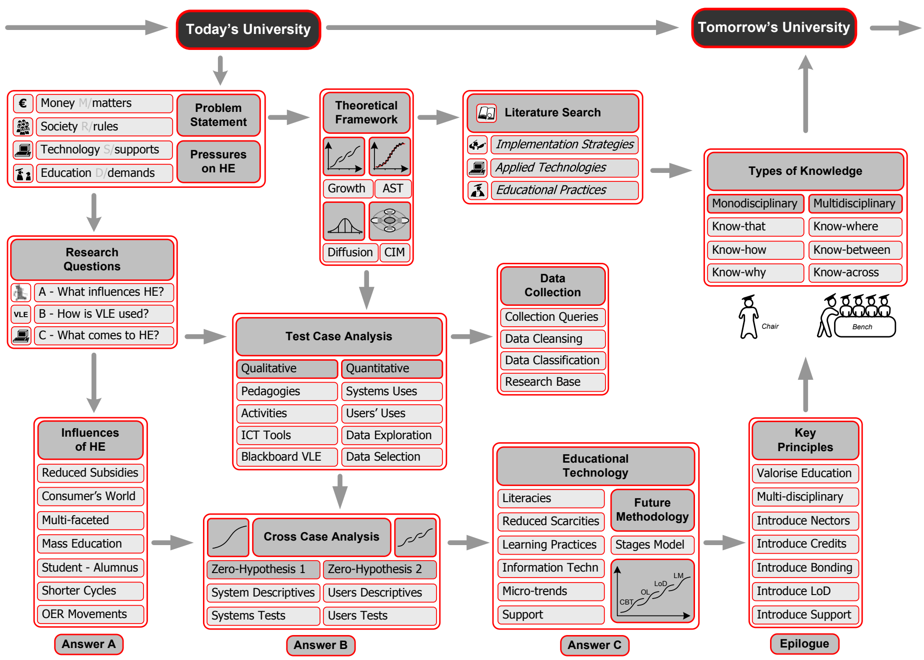


Figure 1: Conceptual Framework with Overview of Study by A.H.W. van der Zanden

Various developments have had a significant influence in the shaping of today's higher education, such as governmental regulations and education subsidies (Laurillard, 2002; Mora, 2007; Vossensteyn, 2007); societal influences, such as jobs and knowledge (OECD, 2000), information and communication technologies (Garrison & Anderson, 2003; Khader & Barnes, 1999; Laurillard, 2002; Senn, 2003); and educational policies (Plasterk, 2007). These multi-faceted influences have given rise to enormous pressures on the daily operations of a university and led us to today's higher education **problem statement**:

> ***Higher education is directly and indirectly subjected to pressures of diminishing subsidies, increasing student populations, labour demands, proliferation of technology, and new educational approaches and practices. Higher education must change to cope with such pressures.***

The literature body on education is huge. We used the Education Resources Information Center (ERIC) database. We chose ERIC because it holds articles from all sorts of journals, both high ISI rated journals and low cited journals. Moreover, books and conference proceedings are also available online or at least the references to them. ERIC holds more than 1.2 million items indexed since 1966. We discerned three major streams of publications in our literature study:

- **educational practices** with teaching and learning approaches
- **applied technologies** within such practices
- **implementation strategies** to set such educational practices at work

The role of ICT is considered to be a catalyst (Cross, 2006). ICT enables the processes to become more efficient, and it also changes the nature of these processes (Veen & Vrakking, 2006). ICT is changing the way in which we deal and process information, it is changing the way we communicate and share information, and it is changing the way we create new knowledge. Hence, it changes the way we learn and higher education is being forced to change its position accordingly. This led us to our main **research question**:

How might higher education cope with current and upcoming pressures of technology on education?

To answer the main research question we specified sub questions to make it operational and executable. We wanted to formulate design principles for the next generation university, hence, we needed insight into how today's university got its shape and what developments played an important role in this shaping process. This led us to research sub question A:

A. What developments have had or have an influence on higher education?

The timeline presents an image of higher education archetypes in Western Europe from its inception in the Renaissance (first generation university), through the radical times of Enlightenment (second generation university) until today, where we are on our way to the next radical shift in education history. Some typical characterics of the three archetypes could be discerned and are presented in Figure 2.

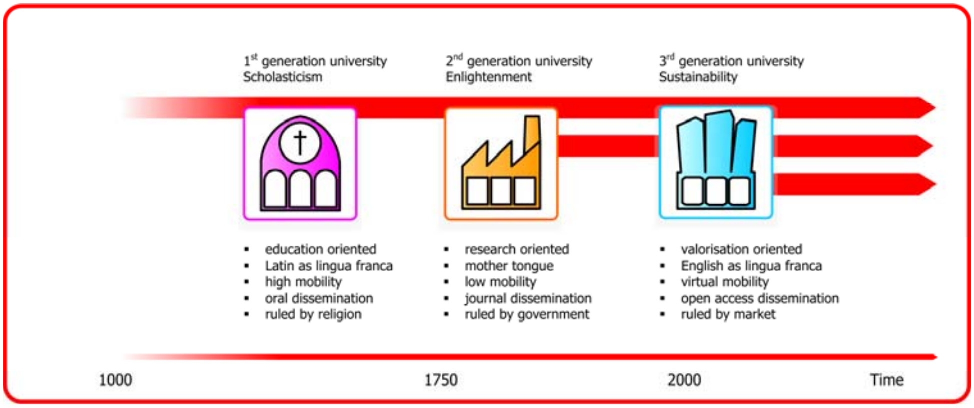


Figure 2: University Generations with Typical Characteristics by A.H.W. van der Zanden

We placed educational practices and applied technologies, two of the three main literature streams, on a timeline to give meaning to our gained insights. The literature showed us that ICT has had an increasingly influence on educational technologies, several of these technologies have been used to enhance educational practices. We distinguished three practices and technologies: computer based training (CBT) at personal computers since the 1980s, online learning (OL) in virtual learning environments since the 2000s, and the learning-on-demand (LoD) educational practice using emerging technologies such as social portals and repositories. Typical characteristics are presented in Figure 3. Note: electronic data processing (EDP) has supported the introduction of automated test taking and statisticals on mainframes since the 1960s, however, the technology was expensive and not widely available.

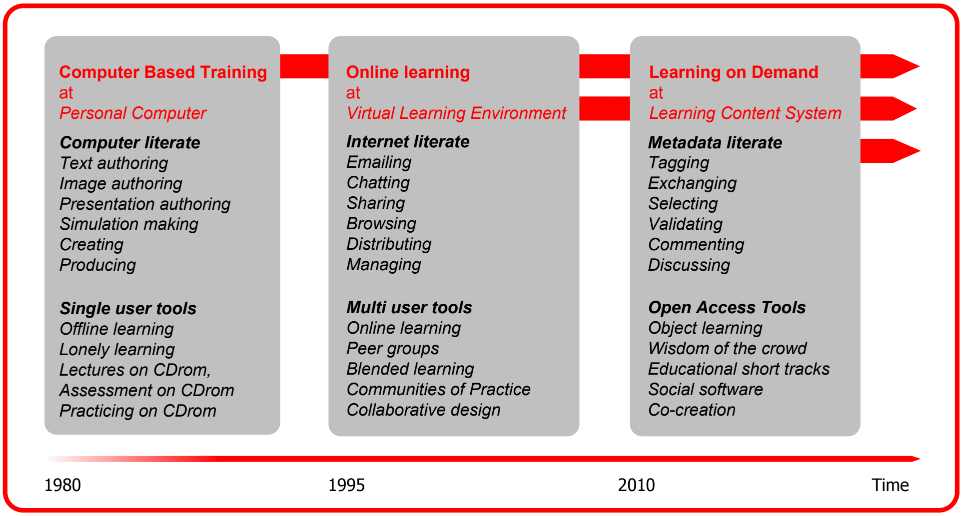


Figure 3: Timeline Overview of Educational Technology and Practices by A.H.W. van der Zanden

The developments that influence higher education, and which answer research sub question A are presented in Table 1, together with their counter measurements. The French Revolution brought enormous changes within the Western world and today's globalisation of economics, of markets, of products, with English as the language of communication, supported and driven by Internet technologies, is also causing enormous changes on a global scale.

Table 1: Higher Education Influences and Counter Measurements as collected by A.H.W. van der Zanden

Influence	***Counter Measurement***
Diminishing subsidies	*Valorisation of education and research becomes more important, it will evolve into its own third primary process. Education and research have to earn money by creating alternative incomes. Accordingly, new metrics need to be set up for education and research outputs.*
Consumer's world	*Students must be equipped with sense and responce strategies to operate in a multi-disciplinary world, one which they will face when they start work. The university must focus on creation and operationalisation of knowledge products and services. Entrepreneurship must be institutionalised to valorise these knowledge products and services. The mono-disciplines have to match approaches, methods and techniques with multi-disciplinary instruction and practice.*
Complex multi-faceted projects	*The education process will differentiate into teaching mono-disciplinary educational tracks and coaching multi-disciplinary projects, which will be authentic, ill-structured projects from paying customers. Teachers must prepare to deal with such developments.*
Mass education and higher student mobility	*The higher income for universities due to increasing student numbers is welcome but the alma mater umbilical bond between student and university weakens, hence the university can emphasise its uniqueness of education by institutionalising multi-disciplinary education tracks. The university can also strengthen the alma mater feeling with social programmes and interacting human networks.*
Today's student is tomorrow's alumnus and customer.	*Customers will contribute with authentic project assignments for multi-disciplinary education tracks when the alma mater feeling remains strong, hence, universities should nourish students instead of*

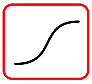
	efficiency; love the person and not the process. Emphasise on motivation of the student and it will pay back tomorrow. It looks like a trend begins, to be set for funding of professoral chairs by corporations and entrepreneurs, but students must be considered the university's capital.
Shorter knowledge life cycles and shorter product to market cycles	*An education-permanente attitude for the student and alumnus should be supported by taking care of online and validated information centres or knowledge centres built on repository architectures with additional social software portals. Educational achievements explained in graduating figures should be extended with portfolios and degree supplements to indicate obtained levels of knowledge, skills and competences, but also for communicative, informational and managerial skills.*
Open Education Resource movement	*The OER movement is organising in world wide structures. The trend to open knowledge for free seems to be non-stoppable, hence, an incentive system is needed for education to contribute to the movement. New metrics are necessary to value educational output and motivate the teaching force to collaborate.*

The French Revolution came at a time of transition from the first to the second generation university, the Internet revolution comes hand in hand with the transition from the second to the third generation university. The education is breaking away from normalised lecture hours, of the controlling attitude, long holidays, talking head instruction and faculty boundaries based on mono-disciplines as isolated educational tracks. The instruction factory of the second generation university is not banned and will retain its value as a means to teach mono-disciplines. The many developments in education indicate that the changes towards a transition from a second to third generation university began in the 1960s, and they will continue, gaining in intensity.

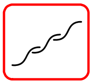
B. How is the Blackboard VLE used within higher education?

We conducted a quantitative study on growth patterns and users' uses on 289 Blackboard virtual learning environments (VLE), to give meaning to the implementation of the VLE. This was our third main literature stream. The Blackboard VLE has become the dominant technology used within higher education in Western Europe and the United States (Bradford et al., 2007; Falvo & Johnson, 2007).

Consequently, we wanted to determine how the higher education institutions used such educational technology, and how growth and diffusion took place within these institutions. We wanted to know how teachers and students used the VLE, and if their uses followed certain patterns. Such led us to the second research sub question and its two connected hypotheses. We wanted to find out if there was a connection between the evolution of universities as synthesised from the literature search and the discrete VLE logging data of Blackboard. An explorative case study together with quantitative analysis and testing two hypotheses helped us to answer research question B.



Hypothesis 1:
Implementation of VLE educational technology will grow along an S-shaped curve in time



Hypothesis 2:
The uses of the VLE functionalities follow minor successive S-shaped curves in time as part of the greater VLE's S-shaped curve

After scrinunising the logging data. We were able to set up a classification schema for all of the 289 collected samples. We focussed on the ScienceClass level, CourseClass level, InstituteClass level, and ServiceClass level to answer the first hypothesis. To answer the second hypothesis we focussed on 'higher education' from the InstituteClass Level, on Course 'F' and Community 'C' from the ServiceClass Level, on the roles 'student', ‘faculty’, and ‘staff’ from the UserClass Level, and on all the 23 Handles from the ActivityClass Level. The items used to answer hypothesis 2 are marked in yellow in Figure 4.

We studied the implementation strategy for the educational practice of online learning and underlying VLE technology. This delivered growth patterns for the system’s level and the users’ level which we discussed in descriptive and test analyses. We were able to demonstrate an S-shaped growth curve for the VLE. Growth patterns were captured in a formula with parameters for amplitude, period and slope. Average growth patterns were calculated for Communities and Courses to determine their implementation grades, presented in the following formulas:

*F1: Community Implementation Grade = Max.Communities * Exp(-3.166 * Exp(-0.043 * LifespanMonth))*
*F2: Course Implementation Grade = Max.Courses * Exp(-3.200 * Exp(-0.037 * LifespanMonth))*

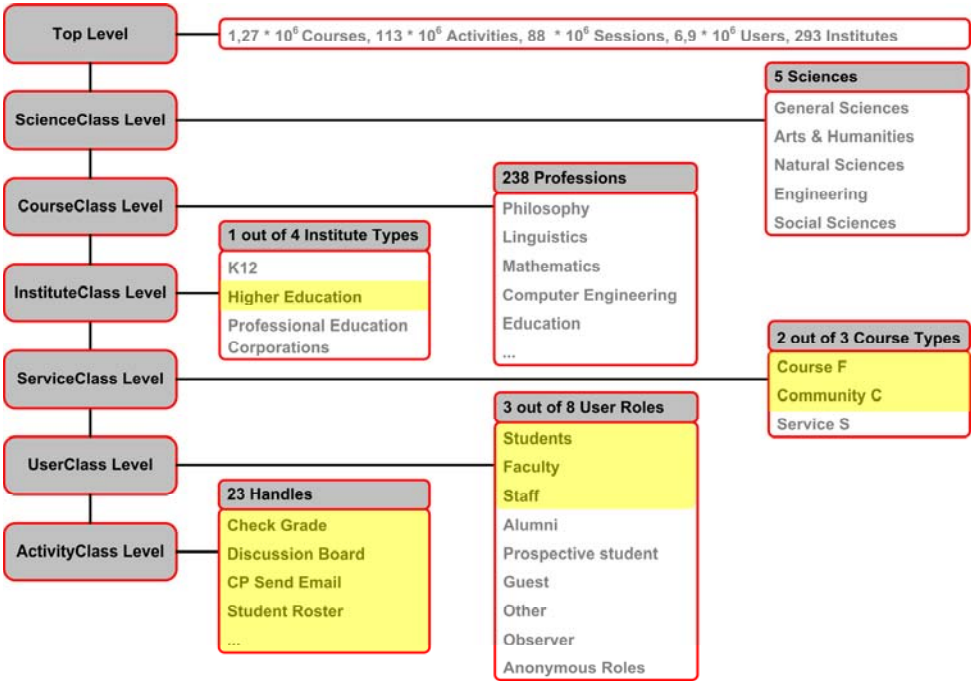


Figure 4: Classification Schema for the obtained Blackboard VLE Logging Data

Our inductive approach (Miles & Huberman, 1994) in search of recurrent phenomena within the collected datasets corroborated with an S-curve like growth for the use of VLE systems within higher education. In order to catch the growth in a formula, we took the Gompertz curve as a model to determine the S-curve pattern, and its variables, using nonlinear regression as the curve fitting mode. In the formulas, ‘Max’ represents the maximum number of possible communities or courses within an institute. If we consider the results and take the overall mean and standard deviation of ScienceClasses from Communities and Courses, the Lifespan period of VLE systems can be assumed 231.1 Lifespan months, or 19.26 Lifespan years, with standard deviation of 44.8 Lifespan months. We could validate hypothesis 1.

VLE’s mean Lifespan is 19.26 years with standard deviation of 3.73 years

For hypothesis 2 we introduced indicators for the users' uses, caught under seat time activities. We found that many communities and courses had no educational activity; these were generated automatically at the beginning of a new academic year. We analysed the seat time activities for 6 subsets: student, faculty and staff for both Communities and Courses, and found that work periods of 8 hours for student, faculty and staff are common, however, the work periods are spread over the day. Thus the Blackboard VLE is always occupied.

All the VLE users started with zapping behaviour in the first minutes after logging-on to check multiple communities or courses. Shorter and longer sessions were quite proportionally distributed for all of the users, both for duration and moment of the day. It struck us that only a few ActivityClasses were popular, determining the type of usage for the VLE. Students had no observable change in behaviour, neither in duration nor in their seat time moment, however, their activities clearly showed community oriented activities from the start. When more information and content came online they directly made use of it. Faculty and staff did change their focus of activities over the years.

The implementation of the several activities grew along S-shaped curves and the community and course oriented activities followed more or less successively over the lifespan. This allowed us to catch the implementation grade of the seat time activities with reliable figures. We could confidently state that hypothesis 2 is valid for the first seven lifespan years of the VLE.

C. What is the new educational technology that will be used in universities?

We followed a future methodology strategy for research sub question C to forecast a future educational practice based on today's knowledge. In Figure 5 the developments are presented in a Futures Wheel composition. These developments influence the possible shape of educational technology for the near future.

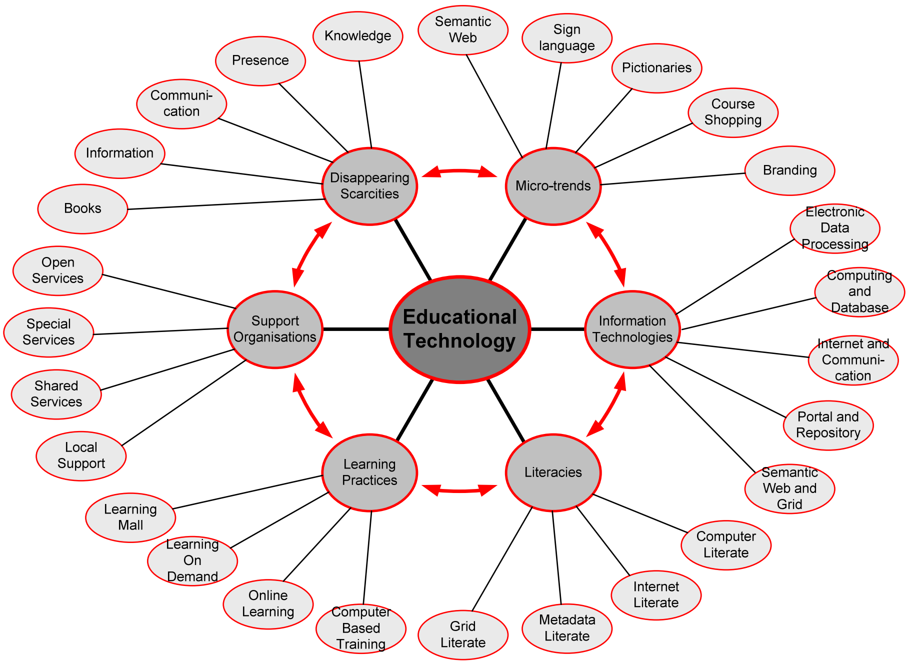


Figure 5: Developments influencing the Shape of Future Educational Technology by A.H.W. van der Zanden

The insights gained and derivations determined from the developments that shape future's educational technology gave us the opportunity to transpose our empirical findings into a Stages Model for Educational Technology architecture. Educational practices are built on such successive educational technologies, which gave us an opportunity to indicate possible learning practices for the near future.

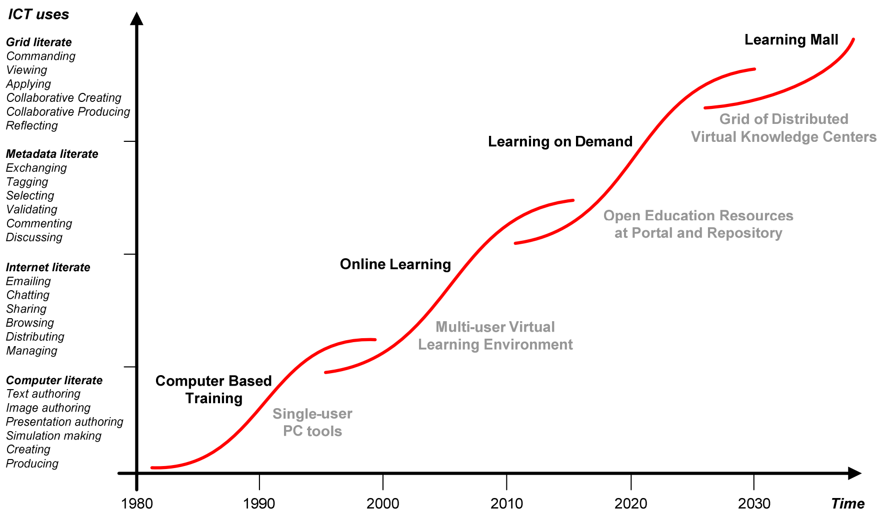


Figure 6: Stages Model for Educational Technology Architectures by A.H.W. van der Zanden

Epilogue: which key principles can be formulated for a facilitating university?

Learning malls, built as virtual knowledge centres, sets the future university as a node in a network, as a brand in a ring-of-universities, accessible to the public and peers. Learning materials are open to be used through out society and to be criticised by society, students and life-long-learners.
Consequently, future universities will step down from their elite position to manifest themselves as knowledge portals for everyone, they will interconnect with public and private organisations to operate as knowledge provider and knowledge broker for complex ill-structured situations. In such way we are heading for networked organisations in a networked world as is shown in Figure 7. We were able to describe which policies might fit with this sketched future educational practice in the epilogue.

Seven key principles were derived for educational managers to help them develop the next generation higher education:

- Key Principle 1 – valorise education by delivering products and services for third parties with hard currency in return. Subsequently, introduce income for valorisation projects as a fourth-order money-stream.
- Key Principle 2 – organise credit metrics for the intake of educational valorisation projects (Project Initiation Document) and their decomposition (Project Valorisation Document).
- Key Principle 3 – introduce curricula for interdisciplinary communication and interaction. Assign nectors, associate nectors and assistant nectors to teach and instruct students in proper interdisciplinary knowledge when participating in valorisation projects.
- Key Principle 4 – introduce a Valorisation Committee organisation structure to assess Initiation (PID) and decomposition (PVD) documents and to assign appropriate credits. Work out an appropriate online documentation structure within portals for the valorisation projects.

- Key Principle 5 - bond students to the university with alma mater activities, such as social programs, buddy programs, community programs, tailored learning and meeting spaces.
- Key Principle 6 – organise capacity in project teams to design the learning on demand practice. Appoint and train people, develop repositories, metadata learning materials, develop portals for interaction and search strategies, develop plans, scenarios and scripts, in programmes of at least 3 to 5 years.
- Key Principle 7 – organise the composition of technology for learning-on-demand practice in collaborating project teams. Build pilot projects for periods of at least 3 to 5 years to create a sound and robust platform.

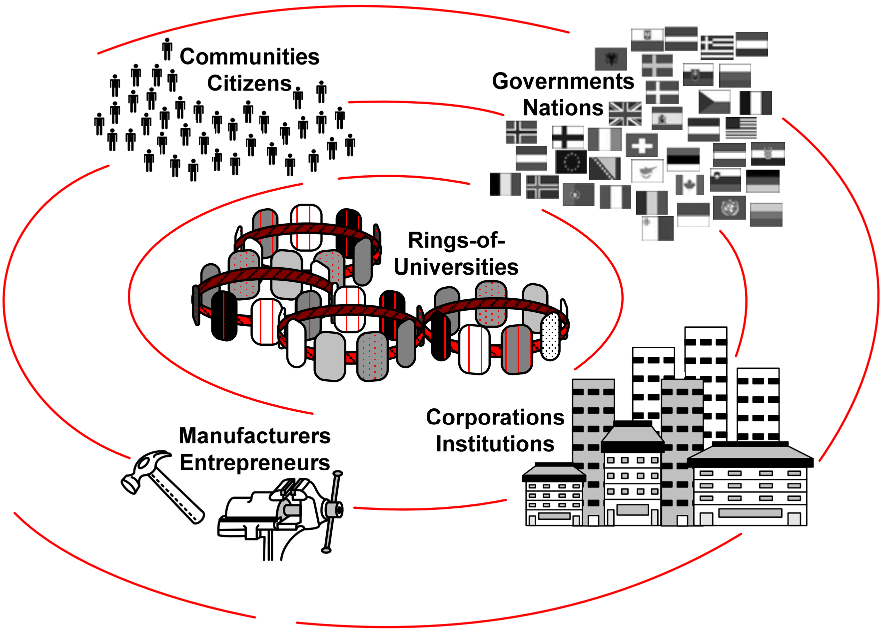


Figure 7: Nodes in Networks connect for Communication, Democratisation, Exploration and Co-creation

The Organisation for Economic Co-operation and Development states that in the future "working is learning" (OECD, 2000). Our seven key principles will help universities to aim at a learning environment where learning and working are inseparable. It is not clear which developments influence higher education the most, but we do know from our findings that we can manipulate the rate-of-change for implementation of new technologies. Consequently, educational managers have steering power over educational technology developments: install technologies, support them, build physical learning spaces (Oblinger, 2006) and let these artefacts do the job of appropriation and structuration (DeSanctis & Poole, 1994) of educational technologies within higher education. Future education will be flexible, will increasingly facilitate ways of personalisation and will stimulate multi-disciplinary collaboration between universities, corporations, government and other organisations.

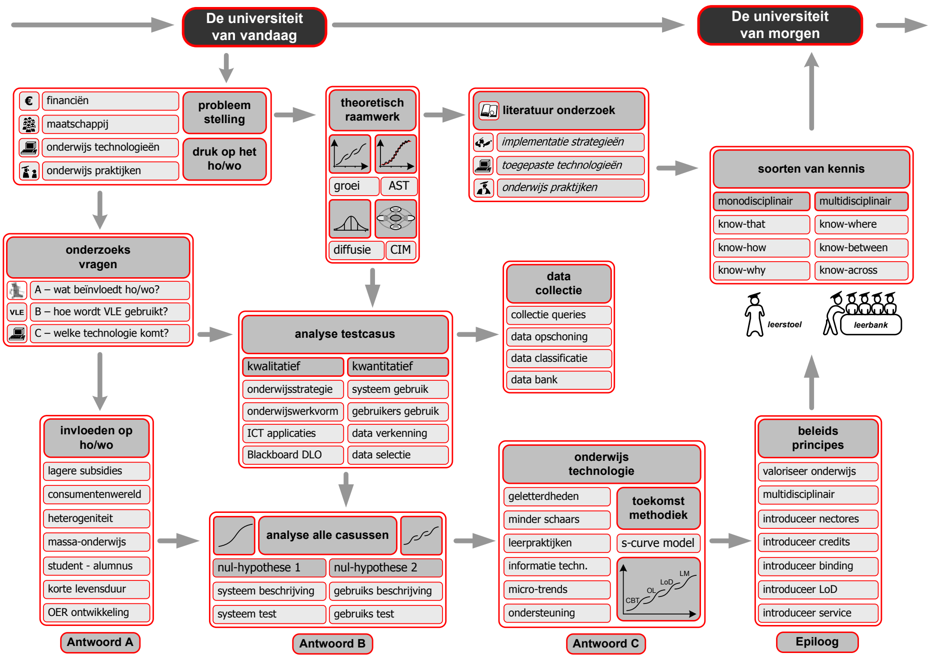
Piet van der Zanden
December 10, 2009.

11 SAMENVATTING

DE FACILITERENDE UNIVERSITEIT

Positionering van toekomstige onderwijstechnologie

De stappen van het onderliggende promotieonderzoek worden schematisch gepresenteerd in het conceptuele overzicht van Figuur 1. Bovenin wordt de 'universiteit van vandaag' gepositioneerd op weg naar de 'universiteit van morgen'. Een initieel literatuuronderzoek is uitgevoerd om de huidige situatie van het hoger onderwijs in kaart te brengen. Het literatuuronderzoek en het theoretisch raamwerk, midden bovenin, liepen gedurende de gehele studie als een rode draad door de ondernomen activiteiten.



Figuur 1: Conceptueel overzicht van het promotieonderzoek van A.H.W. van der Zanden

Aan de linkerzijde staan de onderzoeksvragen aangegeven. De uitkomsten van de drie onderzoeksvragen worden onderin de figuur getoond. Het antwoord op onderzoeksvraag A is afgeleid vanuit de literatuur. Het antwoord op onderzoeksvraag B is gevonden vanuit verkenning van de Blackboard digitale leeromgeving (DLO) als testcasus, vanuit het kwalitatieve onderzoek onder 135 docenten, en vanuit het kwantitatieve onderzoek van 289 verschillende maar anonieme Blackboard DLOs. Het antwoord op onderzoeksvraag C is gecomponeerd vanuit verzamelde micro-trends waarvan wij menen dat die in de toekomst een grote rol zullen spelen en ook op het voorspellen van toekomstige onderwijstechnologie ingegeven door onze empirische uitkomsten.

Diverse ontwikkelingen hebben een belangrijke invloed gehad in de vorming van het hoger onderwijs van vandaag, zoals overheidsregelingen en onderwijssubsidies (Laurillard, 2002; Mora, 2007; Vossensteyn, 2007); maatschappelijke invloeden, zoals banen en de kenniseconomie (OECD, 2000), informatie en communicatie technologieën (Garrison & Anderson, 2003; Khader & Barnes, 1999; Laurillard, 2002; Senn, 2003); en onderwijsbeleid (Plasterk, 2007). Deze zeer diverse invloeden zetten een enorme druk op de dagelijkse bedrijfsvoering van een universiteit en hebben geleid tot de volgende **probleemstelling**:

Het hoger onderwijs staat onder druk en is direct en indirect onderhevig aan diverse soorten van invloeden zoals afnemende subsidies, toenemende studentaantallen en heterogeniteit, vergankelijker kennis, veranderende werkcontracten, alomtegenwoordigheid van technologie, en nieuwe op technologie gebaseerde onderwijskundige werkvormen. Het hoger onderwijs moet positie kiezen om zulke invloeden te kunnen plaatsen.

Over onderwijs is een enorme hoeveelheid literatuur voorhanden. Wij hebben gebruik gemaakt van de Education Resources Information Center (ERIC) database. We hebben voor ERIC gekozen omdat het allerlei soorten van onderzoekspublicaties bevat, zoals artikelen van gerommeerde en hoog gewaardeerde tijdschriften, boeken en conferentieartikelen. Soms was de inhoud voorhanden en soms werd verwezen naar uitgevers of bibliotheken. ERIC heeft een index van 1,2 miljoen titels die vanaf 1966 zijn verzameld. Na een uitgebreide literatuurstudie hebben wij drie hoofdstromen onderscheiden in de geboden collectie op het gebied van educatieve technologie:

- **onderwijspraktijken** met onderwijs en leerwerkvormen
- **toegepaste technologieën** binnen zulke onderwijspraktijken
- **implementatie strategieën** om zulke praktijken operationeel te maken

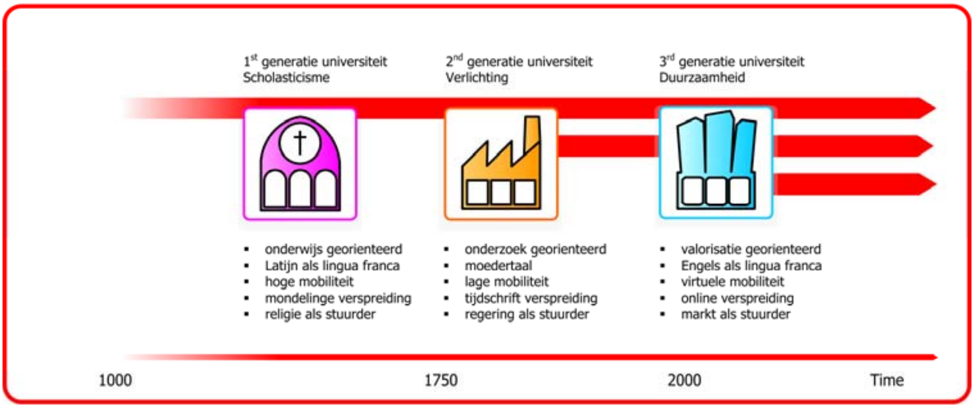
Informatie en Communicatie technologie (ICT) wordt tegenwoordig gezien als een katalysator (Cross, 2006). ICT zorgt er niet alleen voor dat onderwijsprocessen efficiënter verlopen, maar het verandert die onderwijsprocessen zelf ook (Veen & Vrakking, 2006). ICT verandert de manier waarop we met informatie omgaan en hoe we informatie verwerken, het verandert onze wijze van communiceren en informatie delen, en het verandert de manier van kenniscreatie. Het verandert ook onze manier van leren waardoor het hoger onderwijs min of meer wordt gedwongen om zich aan te passen aan zulke manieren van leren. Dit gegeven heeft geleid tot onze algemene **onderzoeksvraag**:

Hoe kan het hoger onderwijs omgaan met de voortdurende ontwikkelingen van technologie en de daarmee samenhangende druk op de onderwijspraktijk?

Om de hoofdonderzoeksvraag te kunnen beantwoorden hebben we het in deelvragen onderverdeeld. We wilden beleidsprincipes voor het toekomstig hoger onderwijs opstellen, zodoende moesten we wel weten hoe het hoger onderwijs van vandaag tot stand is gekomen en welke omstandigheden een belangrijke rol hebben gespeeld in het vormingsproces. Zo zijn we gekomen op de eerste onderzoeksdeelvraag A:

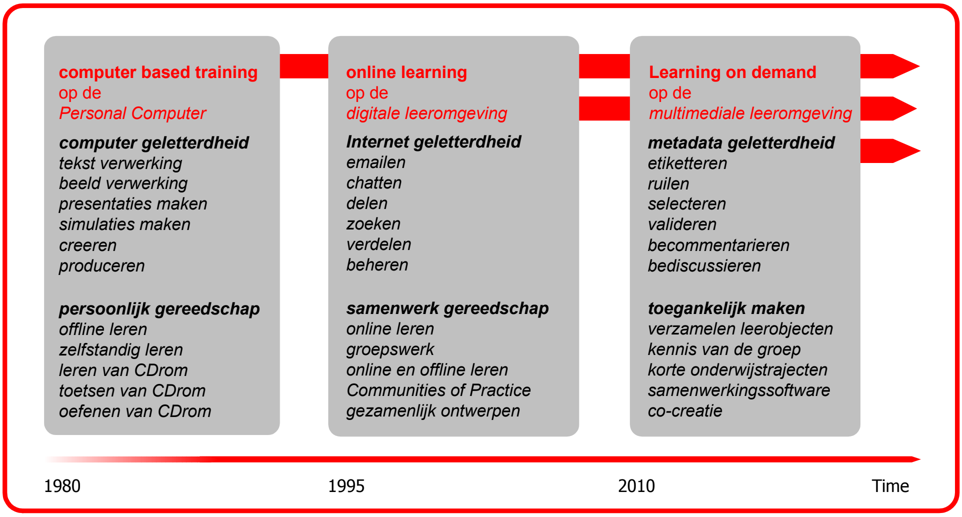
A. Welke ontwikkelingen hadden of hebben invloed gehad op de vorming van het huidige hoger onderwijs?

We hebben de onderwijspraktijken en toegepaste technologieën, als twee van de drie literatuur hoofdstromen, op een tijdlijn geprojecteerd om vorm te geven aan onze verkregen inzichten. De tijdlijn in Figuur 2 representeert een beeld van typische hoger onderwijs archetypen in West Europa vanaf de Renaissance (eerste-generatie universiteit ofwel Scholasticisme), tot aan de Verlichting (tweede-generatie universiteit) tot aan vandaag, waar we op weg zijn naar de volgende radicale verandering in onderwijsland (op naar de derde-generatie universiteit van Duurzaamheid). In de figuur zijn van ieder archetype universiteit een vijftal typische karaktereigenschappen genoemd.



Figuur 2: Drie generaties universteiten met hun typische karakteristieken door A.H.W. van der Zanden

In de literatuur vonden we dat ICT een alsmaar toenemende invloed uitoefent op de onderwijstechnologieën, waarvan sommige het onderwijs werkelijk verbeterd hebben. We hebben een drietal hoofdstromen onderscheiden in onderwijspraktijken en bijbehorende technologieën: *'computer based learning'* op de personal computer sinds de jaren tachtig van de vorige eeuw, *'online learning'* in de digitale leeromgeving sinds de eeuwwisseling en het *'learning on demand'* gesteund door opkomende technologieën als web 2.0 social software en objectdatabanken zoals repositories. Een aantal typische karaktereigenschappen staan genoemd in Figuur 3. Nota bene: in de jaren 60 van de vorige eeuw werden mainframes (grote bedrijfscomputersystemen) wel eens ingezet voor automatische toetsafname en statistische berekeningen, maar die technologie was duur en nauwelijks voorhanden voor het onderwijs.



Figuur 3: Tijdlijnoverzicht van onderwijstechnologieën en onderwijspraktijken door A.H.W. van der Zanden

De ontwikkelingen die het hoger onderwijs hebben beïnvloed en die onderzoeksdeelvraag A beantwoorden, zijn opgenomen in Tabel 1, inclusief de mogelijk te nemen maatregelen. De Franse Revolutie en andere gelijktijdig woedende oorlogen in West-Europa en Noord-Amerika hebben enorme veranderingen teweeggebracht sinds de Verlichting. Vandaag de dag zijn er wederom enorme veranderingen aan de gang in de mondiale economie, in de manier hoe markten opereren, hoe producten tot stand komen, met Engels als voertaal, en alles ondersteund door Internet als 'duwende' technologie. Tijdens de Franse revolutie vond de overgang plaats van de eerste-generatie universiteit naar de tweede-generatie universiteit. De Internet revolutie lijkt parallel te lopen met de overgang van de tweede- naar de derde-generatie universiteit.

Het onderwijs wringt zich uit de genormaliseerde collegeuren op weg naar projectmatige samenwerkingsopdrachten, weg van de controlerende houding gebaseerd op toetsen naar het bouwen van een portfolio aan vaardigheden, weg van de lange zomervakanties die voortkwamen uit het agrarisch tijdperk toen het gewas van het land moest, weg van de alleen maar pratende docenten naar interactieve werkvormen, en op weg naar een multidisciplinaire co-creatie in samenwerkende leerverbanden.

Tabel 1: Invloeden op hoger onderwijs en mogelijke tegenmaatregelen verzameld door A.H.W. van der Zanden

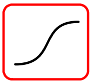
Invloed	***Tegenmaatregel***
Verminderende subsidies	*Valoriseren, ofwel het omzetten van kennis in producten en diensten voor geld, van zowel onderwijs als onderzoek wordt steeds belangrijker. Het zal uiteindelijk een eigen bedrijfsproces worden binnen het hoger onderwijs. Onderwijs en onderzoek moeten beide geld verdienen om alternatieve inkomsten voor de universiteit te genereren. Als gevolg van dergelijke ontwikkelingen is een passend puntensysteem nodig om onderwijsoutput te waarderen net als onderzoeksoutput.*
Consumenten wereld	*Studenten moeten worden opgeleid met een servicegerichte en interactieve attitude om zich staande te houden in de multi-disciplinaire wereld, waarin ze terecht komen als professional na hun studie. De universiteit moet zich concentreren op creatie en operationalisering van kennisproducten en -diensten. Ondernemerschap dient te worden geïnstitutionaliseerd om dergelijke producten en diensten te kunnen valoriseren. De huidige monodisciplines moeten afgestemd worden op de benaderingen, methoden en technieken van multidisciplinaire instructie en praktijk.*
Complexe projecten	*Het onderwijs zal zich differentiëren in instructie van monodisciplinaire cursussen en in het afstemmen, begeleiden en volvoeren van multidisciplinaire samenwerkingsprojecten, authentieke complexe projecten die worden aangeboden door betalende klanten. Docenten moeten zich zodoende voorbereiden op een dergelijke tweedeling.*
Massa-onderwijs en hogere student mobiliteit	*Het hogere inkomen voor de universiteiten vanwege groeiende studentaantallen was zeer welkom maar het alma mater gevoel tussen student en universiteit zwakt af. Daarom moet de universiteit haar eigen handelsmerk benadrukken met behulp van multidisciplinaire samenwerkingsprojecten. Studenten die aan dergelijke projecten meewerken voelen zich trots, op het project, op elkaar, en op de universiteit. Het alma mater gevoel kan verder versterkt worden door sociale binding, buddynetwerken en interactieve communities.*
De student van vandaag is de alumnus en klant van morgen	*Alumni, afgestudeerde studenten, zullen als werkend professional en klant actief bijdragen met authentieke projectopdrachten voor multidiciplinaire opleidingen als hun alma mater gevoel sterk blijft. Daarom moet de universiteit investeren in de binding met haar studenten en alumni, meer nog dan in efficiëntie van het onderwijsproces; vertroetel de persoon en niet het proces. Leg de nadruk op motivatie van de student en het zal automatisch opleveren. Er ontstaat een trend voor het subsidiëren ofwel doneren van leerstoelen door bedrijven en ondernemers, maar het is de student die als het universitaire kapitaal moet worden beschouwd.*
Kortere houdbaarheid van kennis en kortere product-naar-markt doorloop tijden	*Een leven-lang-leren houding voor de student en professional dient gestimuleerd te worden door het inrichten van online gevalideerde informatie- en kenniscentra gebaseerd op repository architecturen met social software portalen. Onderwijsprestaties voor kennis, vaardigheden en competenties zullen op meer manieren dan cijfers worden getoond, bijvoorbeeld met portfolio's en diploma-supplementen. Daarnaast zullen communicatieve, informationele en managementvaardigheden een grotere rol spelen in het onderwijs.*
Open Education Resource beweging	*De OER beweging (vrij beschikbaar onderwijsmateriaal) komt wereldwijd steeds sterker op; de groei van open toegankelijke gratis kennis lijkt niet de stoppen. Een waarderingssysteem is nodig voor het onderwijs, zodat docenten worden gemotiveerd om bij te dragen met OER materialen van hun eigen vakgebied.*

De ‘onderwijsfabriek’ van de tweede generatie universiteit wordt niet zomaar verbannen en zal haar waarde behouden voor monodisciplinair onderwijs. Echter, de vele ontwikkelingen in onderwijsland geven aan dat veranderingen richting de derde-generatie universiteit al waren ingezet in de jaren zestig van de vorige eeuw.

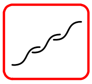
B. Hoe is de Blackboard digitale leeromgeving gebruikt in hoger onderwijs?

Om invulling te geven aan de implementatie, als derde literatuur hoofdstroom, hebben we een kwantitatieve studie uitgevoerd naar wetmatigheden in de groei en het gebruik van 289 digitale leeromgevingen (DLO). De Blackboard DLO heeft een enorm marktaandeel verworven en wordt als meeste toegepast in West-Europa en Noord-Amerika (Bradford et al., 2007; Falvo & Johnson, 2007). Als gevolg van deze massale toepassing in het hoger onderwijs wilden wij weten hoe het werd toegepast, hoe het gebruik ervan is toegenomen en hoe de spreiding is verlopen. We wilden eveneens weten hoe docenten en studenten de DLO gebruikten en of alles volgens bepaalde patronen zou verlopen. Zo zijn we aan onze tweede onderzoeksdeelvraag gekomen en hebben we twee gelieerde hypothesen opgesteld.

We wilden weten of er een relatie te leggen was tussen de evolutie van de diverse generaties universiteiten, zoals we die vanuit de literatuur hadden gedestilleerd, en de discrete logging data van de Blackboard DLO. Een verkennende studie gecombineerd met een kwantitatieve analyse en het toetsen van de twee hypothesen hebben geholpen om onderzoeksdeelvraag B te beantwoorden.



hypothese 1:
De DLO implementatie verloopt langs een S-vormige curve in de tijd



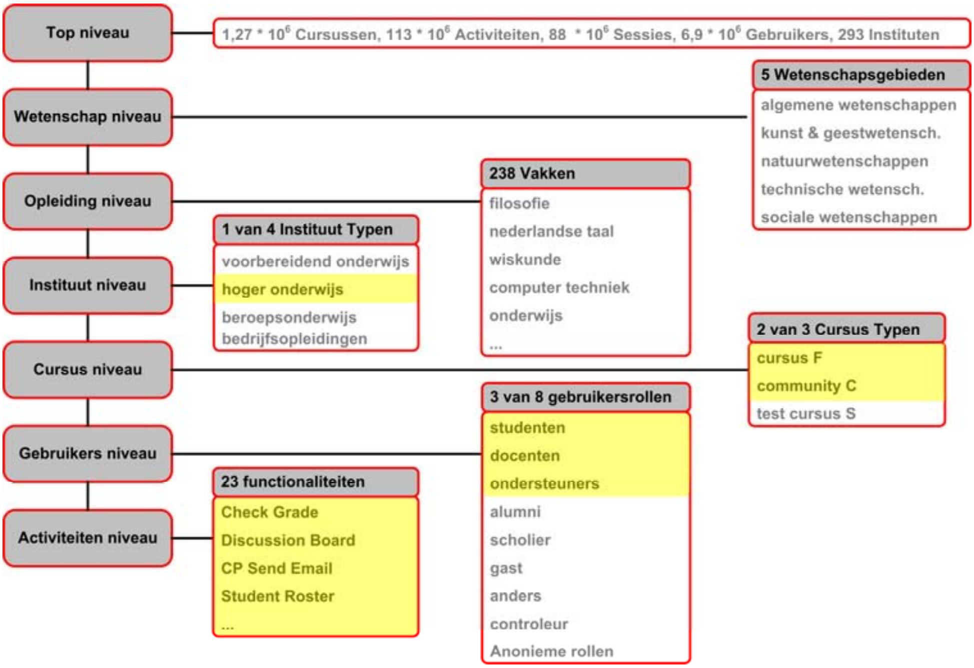
hypothese 2:
De diverse DLO functies, uitgedrukt in groei van gebruik, verlopen langs kleine opeenvolgende S-vormige curven

Na het minitieus nagaan van de logging data waren we in staat om een classificatie schema op te zetten voor de 289 verzamelde datasets. We richtten ons op het wetenschapsniveau, opleidingsniveau, instituutsniveau en het cursusniveau voor hypothese 1. Om hypothese 2 te beantwoorden hebben we ons gericht op het hoger onderwijs, op cursussen en communities, op de rollen student, docent en ondersteuner en op alle toegepaste functionaliteiten van de digitale leeromgeving.

We hebben de implementaties van de ‘online learning’ onderwijspraktijk met onderliggende digitale leeromgeving technologie bestudeerd en vonden groeipatronen op systeemniveau en op gebruikersniveau. Deze hebben we besproken in de beschrijvende en toetsende analyse van hoofdstuk 5. We konden aantonen dat de digitale leeromgeving volgens een bepaalde S-vormige curve toenam, die kon worden uitgedrukt in een formule met amplitude, periode en helling. Patronen zijn berekend voor communities en cursussen om hun implementatiegraad te presenteren, zie onderstaande formules:

*F1: Community Implementation Grade = Max.Comms * Exp(-3.166 * Exp(-0.043 * LifespanMonth))*
*F2: Course Implementation Grade = Max.Courses * Exp(-3.200 * Exp(-0.037 * LifespanMonth))*

Onze inductieve aanpak (Miles & Huberman, 1994) op zoek naar zich herhalende fenomenen in de verzamelde datasets ondersteunde de gedachte van S-vormige groeicurven binnen het hoger onderwijs. We hebben de Gompertz curve gebruikt om de groei in cijfers te vangen met behulp van een niet-lineaire regressiemethode. De “*Max*” waarden staan voor het maximum aan mogelijke communities en cursussen binnen een instituut.



Figuur 4: Classificatieschema van de verkregen Blackboard DLO logging data

Als we de verkregen waarden beschouwen en het algemeen gemiddelde met standaard afwijking nemen, dan kan de technische levensduur op 231,1 maanden ofwel 19,26 jaren worden gesteld, met een standaard afwijking van 44,8 maanden ofwel 3.73 jaar. Zo konden we hypothese 1 als waar beschouwen.

De DLO's levensduur is 19,26 jaar met een standaard afwijking van 3,73 jaar

We hebben activiteitsindicatoren geïntroduceerd om hypothese 2 te toetsen. We hebben 6 deelverzamelingen geanalyseerd: student, docent en ondersteuner voor zowel communities als voor cursussen. We vonden dat zowel student, docent als ondersteuner allen werkdagen van 8 uur hadden, maar dat die werktijden werden verspreid over de 24 uren van de dag. De Blackboard digitale leeromgeving is eigenlijk altijd in gebruik. Opvallend was dat alle DLO gebruikers startten met een zap gedrag. In de eerste minuten na het inloggen worden de communities en cursussen gecheckt op berichten en veranderingen. De kortere en langere sessies waren evenredig verdeeld over de dag, zowel voor de duur van de sessie als voor het moment van de dag. Het viel ons wel op dat er maar een paar functionaliteiten werden gebruikt, waarmee eigenlijk het gebruik van de DLO werd getypeerd. De docent maakt vooral gebruik van functionaliteiten die gemakkelijk zijn en die tijd besparen, zoals elektronische berichten aan de student. Voorheen moest een melding via prikborden en diverse mailings worden aangegeven, nu kan met een e-mail iedereen worden benaderd met de zekerheid dat de boodschap ook aankomt. Ook het distribueren van aanvullend studiemateriaal via de centrale cursussite bespaart het vermenigvuldigen en andere logistieke handelingen. De student heeft een geconcentreerd punt van informatie (punten, lesmaterialen, meldingen) betreffende de te volgen vakken en communiceert graag online met behulp van het discussion board.

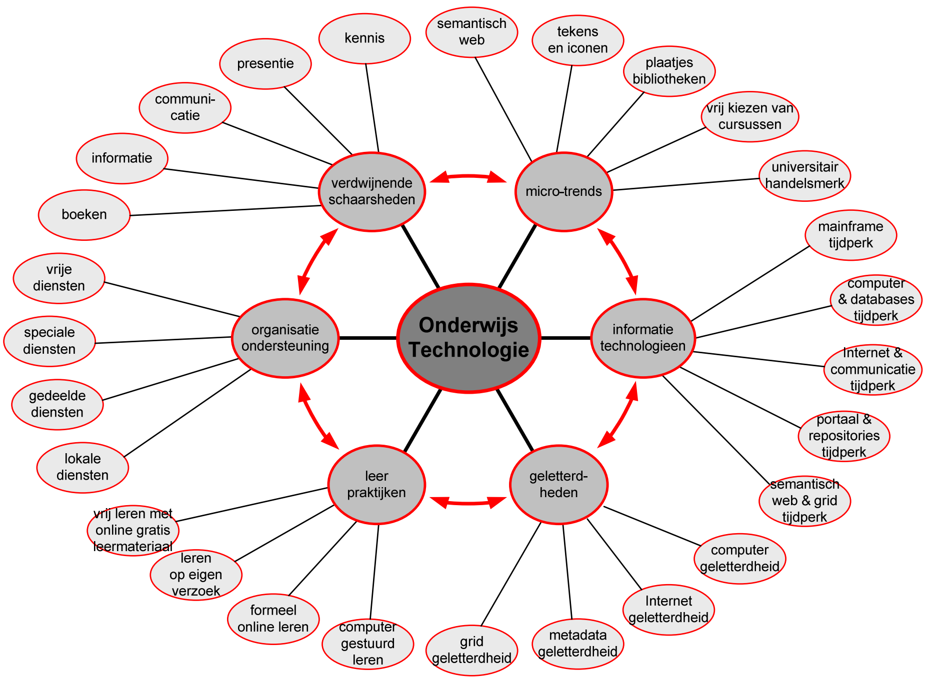
Over de jaren hadden de studenten exact dezelfde wijze van gebruik in duur en moment van de dag, terwijl docenten en ondersteuners de focus van hun activiteiten veranderden, in de eerste jaren werden lange werkdagen gemaakt om de materialen online te krijgen, maar eenmaal gereed leverde het tijdwinst op. Studenten hadden al wel vanaf het begin een community geörienteerde houding. Toen er meer informatie en inhoud online kwam werd er door de studenten direct gebruik van gemaakt.

De implementatie van de diverse activiteiten verliep langs S-vormige curven en de community en cursus geörienteerde activiteiten vulden elkaar aan tijdens het bestaan van de digitale leeromgeving. Dat gaf ons de mogelijkheid om de implementatiegraad van de onderwijsactiviteiten te vangen in betrouwbare cijfers. We konden de 2e hypothese eveneens als waar beschouwen, zij het alleen voor de eerste 7 jaren van de DLO levensduur. Er was helaas niet meer data voorhanden.

C. Welke educatieve technologie zal in de toekomst worden gebruikt?

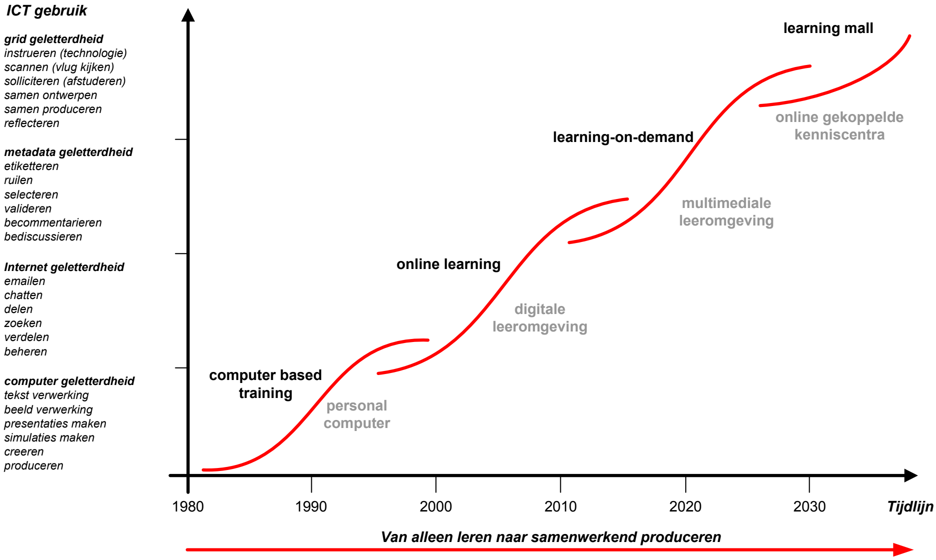
Toekomstbeschrijvingen van complexe organisaties worden over het algemeen gedaan aan de hand van scenariobeschrijvingen, daar is ook veel literatuur over beschikbaar. Wij hebben echter gekozen voor een voorspellingsstrategie (forecasting) die gebaseerd is op de doorontwikkeling van technologie en gebruikelijk is in technische settings.

Om onderzoeksdeelvraag C te beantwoorden hebben we de toekomstige praktijk afgeleid van technologie architecturen die mogelijk in het onderwijs zullen worden toegepast. In Figuur 5 worden diverse ontwikkelingen getoond in een ‘Futures Wheel’ compositie. Die ontwikkelingen beïnvloeden de vorm van het onderwijs voor de nabije toekomst. De inzichten die we verwierven en hebben afgeleid gaven ons de gelegenheid om onze bevindingen te transponeren in een fasemodel voor onderwijstechnologie. De onderwijspraktijken komen voort vanuit de toepassing van die technologiën waarmee we mogelijke leerpraktijken van de toekomst kunnen beschrijven.



Figuur 5: Ontwikkelingen die de universiteit van de toekomst kunnen vormen door A.H.W. van der Zanden

In Figuur 6 zijn onze inzichten samengebracht met op de Y-as de diverse geletterdheden (literacies) en op de X-as de levensduur van de diverse onderwijstechnologiën.



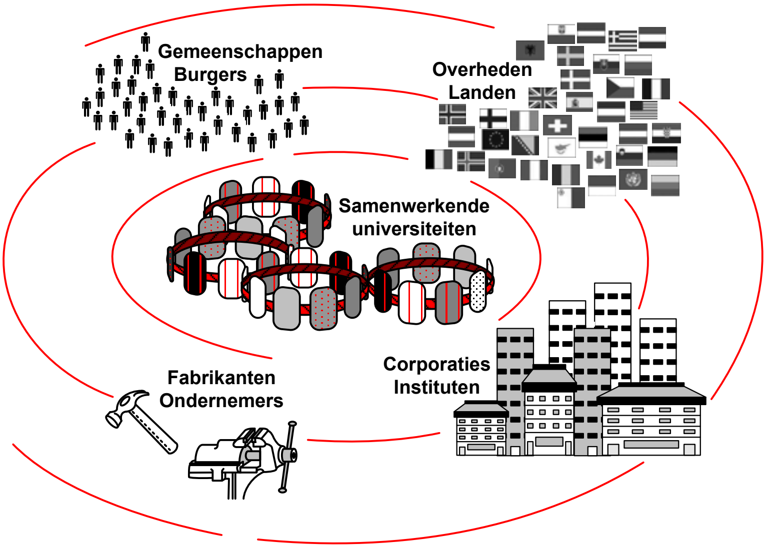
Figuur 6: Fasenmodel voor onderwijstechnologieën en leerpraktijken door A.H.W. van der Zanden

Epiloog: welke beleidsprincipes kunnen worden geformuleerd voor een faciliterende universiteit?

Toekomstige universiteiten opereren als een knooppunt in een netwerk, als een handelsmerk in een coöperatie van universiteiten, toegankelijk voor publiek en professional. Learning Malls zijn de virtuele kenniscentra van de toekomst. Leermaterialen zijn vrij beschikbaar en kunnen worden gebruikt door de student, leven-lang-leerder en iedere andere burger in de maatschappij, maar ook bekritiseerd worden door hen. Als gevolg daarvan zullen de toekomstige universiteiten van hun voetstuk af moeten komen om zichzelf te manifesteren als kennispoorten voor iedereen, universiteiten zullen worden benaderd door publieke en private ondernemingen om als kennisleverancier en kennisoplosser op te treden voor complexe en unieke situaties. Op die manier zijn we op weg naar een genetwerkte wereld zoals in Figuur 7 is weergegeven en waren we in staat om zeven beleidsprincipes voor de faciliterende universiteit te formuleren.

- Beleidsprincipe 1 – valoriseer onderwijs door het leveren van producten en diensten aan derden voor geld. Introduceer een aanvullende (vierde) geldstroom voor het valoriseren van authentieke onderwijsprojecten.
- Beleidsprincipe 2 – organiseer een onderwijsoutput waarderingsysteem voor het beschrijven van onderwijsvalorisatieprojecten (Project Initiation Document) en de decompositie in studentdeelprojecten (Project Valorisation Document).
- Beleidsprincipe 3 – introduceer curricula voor interdisciplinaire communicatie en interactie. Stel zogenoemde nectors aan, interdisciplinaire professors, om studenten te onderwijzen en te instrueren in interdisciplinaire kennis zodat zij kunnen deelnemen aan valorisatieprojecten.
- Beleidsprincipe 4 – introduceer een valorisatiestructuur om de Initiatie (PID) en decompositie (PVD) documenten te waarderen met passende credits. Werk een online documentatiestructuur uit met online portalen voor de valorisatieprojecten.

- Beleidsprincipe 5 - bind de studenten steviger aan de universiteit met zogenaamde alma-mater activiteiten, zoals sociale programma's, buddy programma's, community programma's, maatwerk leeromgevingen en ontmoetingsruimten.
- Beleidsprincipe 6 – organiseer projectcapaciteit om de learning-on-demand onderwijspraktijk te ontwerpen. Stel taskforce en projectteams samen, ontwikkel repositories, metadateer leermaterialen, ontwikkel portalen voor interactie en zoekstrategieën, ontwerp plannen, scenario's en scripts voor de duur van tenminste 3 tot 5 jaar.
- Beleidsprincipe 7 – organiseer de compositie van diverse technologieën om de learning-on-demand onderwijspraktijk vorm te geven met behulp van samenwerkende projectteams. Start pilotprojecten voor de duur van tenminste 3 tot 5 jaar om een gefundeerd en robust platform te organiseren.



Figuur 7: Knooppunten in netwerken faliciteren communicatie, democratie, exploratie en co-creatie

De Organisatie voor Economische Samenwerking en Ontwikkeling stelt dat in de toekomst werken gelijk wordt gesteld aan leren (OECD, 2000). Onze zeven beleidsprincipes helpen de universiteit om een leer- en werkomgeving op te zetten waar het verschil tussen leren en werken niet meer bestaat. Het is echter niet klip en klaar welke ontwikkelingen de meeste invloed hebben, maar we weten wel van onze bevindingen dat de snelheid van implementatie van onderwijstechnologie beïnvloed kan worden door het management. Zij hebben het vermogen om educatieve technologie sneller te implementeren:

Installeer de technologie, ondersteun het, bouw fysieke 'learning spaces' (Oblinger, 2006) en laat deze artefacten hun werk doen. Het gebruik en aanpassen van de onderwijstechnologie zal automatisch plaatsvinden binnen het hoger onderwijs (DeSanctis & Poole, 1994). Het toekomstige onderwijs zal flexibel zijn, het zal steeds meer het gepersonaliseerd leren ondersteunen en het zal de multidisciplinaire samenwerking tussen universiteiten, bedrijven, overheden en andere organisaties stimuleren.

Piet van der Zanden
10 December 2009.

12 APPENDICES

12.1 APPENDIX A: REFLECTION

The influences described in the third Chapter 'Higher Education in Historical Perspective' provide support for further reasoning on the developments to come concerning the interplay between education and technology. This section is an attempt to catch our human characteristics and put them to some easy statements or better put propositions. The propositions are briefly clarified and then used for further thinking and discussion.

12.1.1 Human Kind is on its Way

Many philosophers over the different eras have argued about knowledge and how to achieve it. The discussion about mental reasoning or sense experience as two mainstream learning acquirement practices is still going strong today: but all philosophers agree that human kind develops itsself in one way or the other. Human beings are continuously trying to improve themselves. Sometimes for the better and sometimes for the worse.

Abraham Maslow argues that human's improvement is an innate curiosity, which continuously seeks for higher needs: but higher needs are only aimed for when basic needs are achieved. Maslow's theory is called the 'Hierarchy of Needs' and is often depicted as a pyramid, as shown in Figure 86.

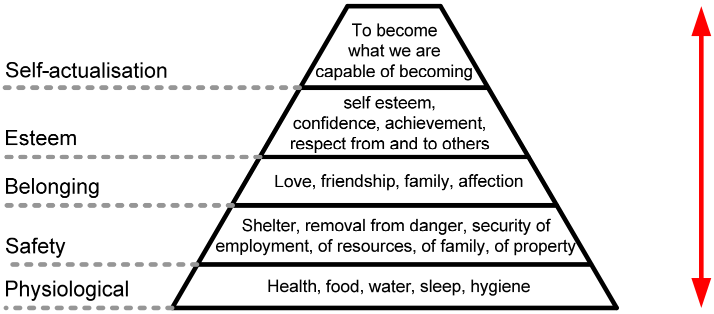


Figure 86: Maslow's Hierarchy of Needs (1943)

The basic concept is that the higher needs only come into focus when the needs that are lower down in the pyramid are satisfied, for instance if we are unwell than little else matters until we are recovered. When an individual has moved up a level, the lower needs no longer have priority. However, if a lower set of needs has not been met for a longer period, then the person will re-prioritise such lower needs, and move one level down (Maslow, 1943).

Such moving up and down in the 'Hierarchy of Needs' depends on many circumstances both inside and outside the individual. Even indirect matters such as the up and down movements of close friends on this pyramid influences an individuals movement, and environmental events such as a war or an economic disaster over which one has no influence will heavily determine movement on the pyramid. According to Maslow in the end the human always aims at a higher level in the hierarchy. Hence human kind is on its way.

12.1.2 Human Kind thinks for Itself

Although according to Maslow the struggle for improvement seems innate, humans are able to take their own decision on how to live their life. A human is strong enough and able to decide not to move up the pyramid, and may choose to continue to live according to a set of chosen circumstances. Such choice means the person wants to live the life as he or she loves it. For instance, some members of the first generation university (Scholasticism) did not want to do research according to the new, overtaking enlightened way of finding the truth. Such first generation devotees endured the divine way to enrich themselves in religion and belief (Eco, 1999; Lodge, 2007). There has been endless discussions about truth taken from the perspective of non-progressive biblical faith. Yet Francis Bacon with his 'Novum Organum' (1620) and even earlier Thomas of Aquinas (Doctor Angelicus) in his 'Summa Theologicae' (1272) were progressive thinkers. Immanuel Kant, as a great thinker of the Enlightenment period posed in his second edition of the 'Kritik der reinen Vernunft' that he had to abolish knowledge to make room for belief or in German "Ich mußte also das Wissen aufheben, um zum Glauben Platz zu bekommen" (Kant, 1787). Kant's statements may be interpreted as a clear message against the earlier schools of thought. Yet both the scholastic and enlightened approaches have continued to be debated through the centuries.

People are free to choose their lives. They make their own decisions according to for instance religion, to live alone and be hermit, to help mankind in far away countries, to foster children, or to offer to help a charity, without for instance, accumulating the trappings of luxury objects for themselves in a material world or without using a scientific approach for finding the truth by reason, they would rather seek richness for their inner selves. Human kind has freedom of choice and therefore we want to quote Kant's words "Sapere Aude", which means 'think for yourself' or 'dare to know'. Hence, human kind thinks for itself.

12.1.3 Human Kind is bound as a Phenomenon

Jean Jacques Rousseau's famous motto was "Man is born free but everywhere he is in chains" or in French "L'homme est né libre, et partout il est dans les fers" as he started in his book 'Du contrat social; ou principes du droit politique' (Rousseau, 1762). Rousseau addressed the French regime, but if we consider the human within their natural physical body, which appears in our real world, than their body is bound to the direct environment in which they appear.

Human kind is on its way and individuals can think for themselves. However, with Rousseau's statement in mind, a person's starting position gives them a head start or an immense delay if compared to other people. A person starts their development in the place where they are born; they have to improve from the situation in which they are raised, where they go to school, where they work, where they live. Human kind seeks to find a way to improve its situation, for instance a person might not want a job with the same level of hard physical work involved as a parent had: but they may want to do that job better, faster and easier than before and if possible using technology as a means to support this.
Such a starting position is a huge determinant for a person's further development. That is to say that the person is bound to the local circumstances, such as poverty or richness, living far out in the country or in the city centre, with believers or free thinkers in their surroundings, with local friends bound to the same chains or influential friends with connections farther out, or professional work bound to a specialist's job such as an oil driller, or bound to an area such as a farmer, and so on and so forth. Such bounding counts for a person's physical body, or better said, for their appearance as a phenomenon on this earth. A body is just a phenomenon in this world.

Right from the starting position on all the opportunities and threads count as boundaries or chains. Such chains make it harder or easier for an individual to break out of the place and space where their parents placed them on this earth. Hence, human kind is bound as a phenomenon.

12.1.4 Human Kind breaks free as Noumenon

Human kind is on its way, thinks for itsself, but this starts from where a person is physically placed on earth when born. However, a person in their thoughts is able to imagine that they are dwelling in another world, just to be somewhere else for a while. In such a state a person is able to separate their thoughts from their physical body. We may say that they are able to part their noumenon from its phenomenon.
The noumenon refers to an object of understanding and cognition. Kant used the term to indicate a thing on itself and not its appearance, in German 'Das Ding an Sich' (Kant, 1787). For our definition we may call it a knowledge entity, which represents the mind and spirit of an individual as opposite to that individual's appearance in the real world. A person's physical appearance or their body as phenomenon is acting as an extension of their noumenon.

Using the internet, it is easy to part the noumenon from its phenomenon. When an individual uses the internet as his or her extension in stead of his or her body through emailing, through electronic discussing or chatting, or when he or she is represented by an avatar, than he or she has split the mind from their body, or their noumenon from their phenomenon. That is to say for the person who approaches him or her from the other site, which is the internet's site. That person is just as if he or she is a virtual appearance or a knowledge entity, thus another noumenon apart from its body. They have unchained their minds from their physical situations.
Such circumstances may reshape morality, the love of art, thoughts, beliefs, and ways of the truth in general. As for instance hunters love the deer, even honouring them, but still they shoot the deer to feed their family, although they know that the breed becoming scarce. At the other side stands a member of the animal protection movement, who also loves the deer and honours it, but they will never shoot the deer, even if their family is starving. Both the hunter and animal protector talk about the same animal, but they still see things differently! Is that because the deer shows itself in different shapes, colours, or time to the different persons? No, it is our free thinking ability, we make the different interpretations based on our moral thoughts; a person makes a free personal construct in their mind.

A person's character does not really change when they are emailing for work, or discussing as student, or striving for justice, because the 'virtual person' is shaped by that person's physical extension. Or, have they changed already? Will they explore things which are not possible in the physical world? Only moral thought holds a person responsible for changing their character. With the internet a person is not bound to their physical constraints and therefore they may act as someone not bound to their real world. The physical body as phenomenon is cast off and as a noumenon persons think for themselves. Hence, human kind breaks free as noumenon.

12.1.5 Human Kind is both Unity and Diversity

A person is both phenomenon and noumenon; they are bound but can break free, they can think for theirselves, and determine their path in life.
What is very interesting is that a person that is one way today can be different tomorrow, because for instance they have learned new things, they have more experience, they have made more friends, they have lost a relative, and so on and so forth. Yet tomorrow they are the same person, with the same children, the same car, and the same haircut. Thus a person can be both the 'same' and 'different'. The self grows out of the self to quote Hegel (Hegel, 1832). Jean-Paul Sartre's famous words "Je suis ce que je ne suis pas, je ne suis pas ce que je suis" (I am who I am not, and I am not who I am) indicate this more specifically (Sartre, 1943). Such simultaneous coexistence versus sameness is an interesting proposition, because in science the attribute 'time' is used in general for explaining cause and effect series over time and not for appearances at one time.

Bloom's taxonomies (1956) present the different states in which human kind's intellectual, emotional and motor developments may occur, and to which level. The movement from one level to another higher level takes time, but how long that takes is unknown and it also is specific for an individual; a person thinks for theirselves. Here, time is a dependent attribute, and if we consider time on things then it can present us different stages of the same thing. If one takes an apple for instance; the apple comes from the blossom, which comes from the sprout, which comes from the tree, which comes from the seed, which comes from the apple. The apple on itself is the cause of its existence, just as many other fruits and species on this earth, as are humans.

If we consider time on itself then it seems a strange concept. It does not have a beginning or an end; it is both finite and infinite (Roodenburg, 2007). Kant argues that we use time only to present things for our own mind, but still human kind stretches it as though we want to indicate changes or growth or otherwise on some sort of calendar.
For instance we need such calendar time to indicate the growth of one single fertilised ovum from two cells to a fully grown adult. The two cells are already a human as a whole, and although the two cells form a unity, it already has the diverse building blocks required for the adult within. It is both unity and diversity, which is called a 'holon' (Lorenz, 2004). The same counts for almost every living organism on this world, such as

the individuals in a community; the individuals are the units and the community is the whole. Human kind is part of the whole and a human is the whole of parts, hence human kind is both unity and diversity.

12.1.6 Human Kind communicates to express Itself

From the moment a person is born they begin to build a 'self-image'. Such self-images are quite realistic but sometimes idealised because of external stimuli or gathered successes or just dreams, and sometimes negatively influenced because of fears for instance. The self-images are compared to others to know actual states and to adapt them when necessary (Lubbe & Zoest, 1997b; Rogers & Farson, 1987). Sometimes it is the deviation that drives a person to actions normally not done, for instance when they think they can fly or when they decide to act as a terrorist. Moral thoughts and environment's feedback should balance the self-image to its right place in society.

Communication occurs through words supported with attitudes, gestures and other non verbal signs (Lubbe & Zoest, 1997a). On the Internet the non visible actions are made visible with smiley's, signs, symbols and icons, which represent the feeling of the messenger. Such semiotic behaviour leading to some sort of sign language is typically caused by shortcomings of the one-dimensional text communication medium such as the Internet is. It is also added to the communication channels because today's electronic devices have it on-board (Berniker & Beard, 2003).

Textual communicative messages added with semiotics can be instructive, informative, confronting, relieving, active, or supportive in order to make the message clear or to make the action done (Mulligan, 1990). Hence, human kind communicates to express themselves.

12.1.7 Human Kind creates Things transcendentally

In the case that many individuals share a similar way of life and they unite then they form a community. Many sorts of communities exist and most of them are shaped by geographical borders, such as the village, commune, city, county, country, or world. There are other borders that also restrict communities, such as work, hobby, religion, belief, imprisonment, governments, and so on. All such communities are based on physical appearances. In the physical body a person is taken custody, and for such reason a person is bound to their neighbourhood, to the friends with which they were raised, their parents, their spouse and their children, but on the Internet they can contact anyone instantly and they are not bound.
In time, while acting as a noumenon, people begin to see that it is easy to change personal views. The environment where their body is dwelling looses its grip on the free thinking noumenon. A person's moral thoughts may be willingly changed and perhaps they will join a community, the type of which they would not normally be member in the physical world.

When many personal views meet they may form an online community or special interest group. When the community grows continuously, then their new view or thought may disseminate, shaping a new virtual paradigm, and when a critical mass is reached, the new virtual paradigm may stand ground. Such a new virtual paradigm can get many followers who want to evangelise it in the real world. They will transform their noumenon thoughts into a vast movement. In such way the new paradigm is pronounced through their phenomena into the physical world. The virtual paradigm becomes real by spreading through the old fashion scientific publications, and perhaps it may overtake the scientific thoughts of the older regime. How unreal would such a transformation be?

Many philosophers have spoken of transcendental processes where thoughts abstracted from the real world are transformed within the mind. After conversation, one individual to another, the original thought leads to a personal construct in the others mind. The other can transform the spoken idea into practice with another goal than the earlier person had in mind and without any problem or even hesitation the transformation is done. In such cases moral thoughts and ethics play important roles. Many examples show such transcendental processes, which led to great discussions. Is it not so that human kind can make tools with impressive power to help people, yet the very same technology can be used to destroy people. Hence, human kind creates things transcendentally.

12.1.8 Human Kind reduces its Brain's Cognitive Load through its Extensions

According to the 'evolution theory' (Darwin, 1859) and 'research of the mind' (CERI, 2007; Sitskoorn, 2006) the size of the brain has not really grown in the last few centuries, let alone the last decades, although it has been discovered that the brain is very plastic and suits a life-long-learning habit. Given the assumed constant of brain size, one might argue that an individual has to divide his or her brain capacity over the separate tasks as indicated in Figure 87.

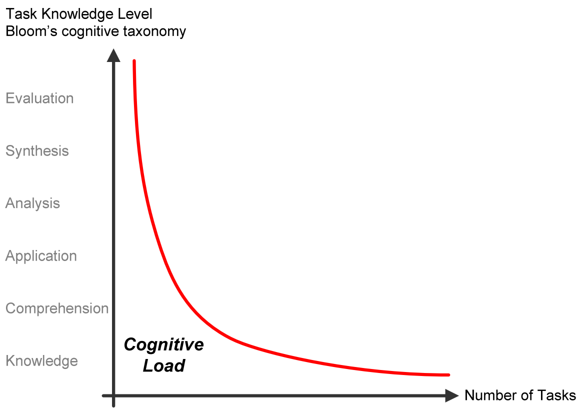


Figure 87: The Brain's Cognitive Load is Finite and is divided over Level or Task by A.H.W. van der Zanden

When such an argument is true, a hyperbolic graph may represent the division of cognitive load over the number of tasks. It is interesting to take Bloom's cognitive taxonomy with the successive levels of cumulative knowledge and set it on the Y-axis next to let the X-axis represent the number of tasks. Despite the author's lack of domain knowledge concerning the brain's cognitive load still one can draw a pattern as shown in Figure 22; the higher the Y-axis (Bloom's knowledge level) the shorter must be the X-axis (Number of Tasks).

The lowest 'knowledge level' represents the recall of data such as facts, figures and formulas. The nice thing is that with the upcoming learning theory 'Connectivism' (Siemens, 2005) in mind such data can be stored in external memory, such as internet, database, mobile or camera. Is it then plausible that internal memory is made free for higher-level tasks? We do not know, maybe in such way, the finite mind can be given extra space or capacity but only when the individual is capable of using such external memory effectively and continuously. When he or she is capable handling the more difficult tasks, such effective use may be enhanced by applied information and communication skills. Hence, human kind extends its brain's cognitive load through its extensions.

12.1.9 Concluding Remarks

Human kind is on its way, it is able to think for itself, it is both phenomenon and noumenon, both unity and diversity, it is bound but can break free, it expresses itself, thinks transcendental, and can artificially extend its brain capacity somewhat. Persons are learners, however restricted in their capacities, and for such reason they must focus and choose professions which suits their needs and comforts. Their needs and comforts are just that personal that communities existing of individuals, who share the same beliefs, thoughts, and ideas, are by definition limited. Be aware of huge collectives, which follow other beliefs or even propagandist messages, such as mass movements, which may not be compared to the personal development path that is mentioned and meant here. Such mass movements were the best solutions for education as it existed in the industrial age. Today, in the information age, when focussed on the development of the individual, personal education tracks would be more appropriate.

It seems easier to fit it in the words such as Karl Marx and Friedrich Engels put it in their 'Die heilige Familie oder Kritik der kritischen Kritik' (1845) on page 60: "Wenn ich mir aus den wirklichen Äpfeln, Birnen, Erdbeeren, Mandeln die allgemeine Vorstellung '*Frucht'* bilde", with which they meant that there are several appearances of the same substance (Marx & Engels, 1844). If such a comparison is made to human kind and the education system, than it all fits for the industrial age. At that time they needed factory workers who did an exact job rather faster and better. The whole system was based on creating drones or standard workers with very little own initiative but with a set of standard skills to stand by the machine production lines (Marx & Engels, 1848).

The education system chased away the individual's creation to output non-thinking workers with the exact same qualities who would not think for themselves. Maybe that is why robots do such a wonderful job in today's factories. Robots are just extensions and indeed do not think for theirselves. Moreover, due to the education system you could recognise and categorise the workers easily by their degrees. Degrees which endured the test of time.

Still today, already sound in the information age, the education system drains the creative skills from the pupils. According to Sir Ken Robinson, chair of the UK Government's report on creativity, education and the economy, young people lost their ability to think in "divergent or non-linear ways" - a key component of creativity. Of 1,600 children aged 3-5 who were tested, 98 percent showed they could think in divergent ways. By the time they were aged 8-10, 32 percent could think divergently. When the same test was applied to 13-15s, only 10 percent could think in this way. And when the test was used with 200,000 25-year-olds, only 2 percent could think divergently (Buie, 2005). But in the information age, human kind has to think for themselves, especially in the continuing changing environments and challenges which come forth from the short product and knowledge life cycles. Human kind must be skilled in both research-like actions as creative-like actions.

Research is about discovering. One can find things, which are already there. The thing or phenomenon is only to reveal itself to the observer. Michelangelo stated that the perfect sculpture or statue was already in the stone, he just had to remove the redundant stone, which did not belong to the statue, to come about. Research is about discovering pattern, it is about 'do what you did to get what you got'.

Creating is about reasoning, combining and engineering. In such case human kind follows a free approach of making things. It is argued that the thoughts of the artist are brought into the stone to create the image, which was already in the mind of the artist. Persons can think for themselves, and such thinking in combination with engineering skills can create new technologies or new phenomena. Such seems to fit perfectly with valorisation and the entrepreneurial state of the today's expected society. Of course it depends of the wanted profession which additional methods and tools have to be mastered.

This reflection gave the author the opportunity of free thinking in order to inspire the reader in even such a way. Communicating and working online gives the user the opportunity to handle in a way, which is unbound from his or her physical environment. Such communicating and working in a hybrid world of man and machine will be the social environment for tomorrow where the sharp distinction between work and free time is blurring.

12.2 APPENDIX B: QUESTIONS ONLINE SURVEY

General:

1. At what faculty do you teach?
   (multiple selections possible)

☐ BK ☐ CiTG ☐ EWI ☐ IO ☐ LR ☐ TBM ☐ TNW ☐ 3mE

2. What academic level(s) do you teach? *(Not BaMa but academic year)*
   (multiple selections possible)

☐ 1st ☐ 2nd ☐ 3rd ☐ 4th ☐ 5th ☐ Graduates ☐ PhD students

3. To what extent do you apply the next pedagogical approaches?

	rarely	not much	regularly	often	always	not applicable
Project-based learning *(uses of techniques and methods on subject matter)*	○	○	○	○	○	○
Productive learning *(design activities for authentic situations)*	○	○	○	○	○	○
Active learning *(behaviourally and cognitively active when learning by doing)*	○	○	○	○	○	○
Collaborative learning *(joint intellectual efforts in groups)*	○	○	○	○	○	○
Coached self study *(individual assigments with personal coaching)*	○	○	○	○	○	○

4. To what extent do you apply the next teaching activities?

	rarely	not much	regularly	often	always	not applicable
Lecture instructor-led	○	○	○	○	○	○
Instruction	○	○	○	○	○	○
Practical	○	○	○	○	○	○
Colstruction (lecture + instruction)	○	○	○	○	○	○
Video lecture of yourself	○	○	○	○	○	○
Video lecture of others	○	○	○	○	○	○
Computer-based training activities	○	○	○	○	○	○
Presentation of assignment	○	○	○	○	○	○
Essay writing	○	○	○	○	○	○
Role playing game without ICT	○	○	○	○	○	○
Role playing game with ICT (online multi-player)	○	○	○	○	○	○
Simulation of models on PC or web	○	○	○	○	○	○
Formative testing	○	○	○	○	○	○
Summative testing	○	○	○	○	○	○
Individual coaching (internship, graduates)	○	○	○	○	○	○

5. In what language do you teach?
   (multiple selections possible)

☐ Dutch ☐ English

6. Can you indicate the total number of credit points (ECTS) of all the courses that you teach?

☐

7. Are you joining the Open CourseWare program?

○ yes ○ no ○ not familiar with

ICT tools:

1. What ICT tools do you use within your (online) educational practice?
(multiple selections possible)

- ☐ PC
- ☐ Laptop
- ☐ Blackboard VLE
- ☐ Surfgroups
- ☐ Email
- ☐ Discussion board
- ☐ Video (snaps) / vodcasting
- ☐ Audio (snaps) / podcasting
- ☐ MSN
- ☐ Skype
- ☐ Wiki
- ☐ Weblog
- ☐ Website
- ☐ Portfolio system
- ☐ Peer review sy
- ☐ Digital testing system
- ☐ Interactivity board (e.g. Smartboard)
- ☐ Games software
- ☐ Simulation programs
- ☐ Automatic look-
- ☐ Other ➡ Ga verder met vraag 31.

Your educational practice:

1. The quality of your educational practice is improved by ...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree	not applicable
... an enrichment of online references such as hyperlinks, images, videos	○	○	○	○	○	○
... an easi(er) way to update your readers	○	○	○	○	○	○
... a fast(er) way to add new materials	○	○	○	○	○	○
... an (more) efficient way for electronic testing	○	○	○	○	○	○
... obtaining critiques and comments at your website, wiki, or blogsite	○	○	○	○	○	○
... two-way communication with students and peers	○	○	○	○	○	○
... students adding their learning materials	○	○	○	○	○	○

2. Can you clarify your choices?
(please answer strong but short)

3. The ICT tools came into your practice due to ...
(multiple selections possible)

- ☐ ... your own initiative
- ☐ ... a colleague's advice
- ☐ ... idea's of the department or faculty
- ☐ ... obligatory regulations of the department or faculty
- ☐ ... cooperation with non-TU Delft colleagues
- ☐ ... the university's ICT in Education Program
- ☐ ... a European project
- ☐ ... other ➡ Ga verder met vraag 32.

About Blackboard:

1. At what *'Year – Month'* did you start to use the Blackboard VLE? *(yyyy–mm)*

2. List your top 3 functionalities of the Blackboard VLE?
(use keywords, and comma–seperate the functionalities)

3. List your 3 most worse functionalities (or impediments) of the Blackboard VLE?
(use keywords, and comma–seperate the functionalities)

4. For what educational purposes do you set the Blackboard VLE at work?
(please answer strong but short)

5. To what extent do you apply Blackboard in your educational practice for ...

	rarely	not much	regularly	often	always	not applicable
... easi(er) distribution of learning materials	○	○	○	○	○	○
... easi(er) communication of announcements	○	○	○	○	○	○
... online collaboration	○	○	○	○	○	○
... using videos for instruction, explaination, propositions	○	○	○	○	○	○
... assignments before the next lecture	○	○	○	○	○	○
... using online testing	○	○	○	○	○	○
... submission of assignments	○	○	○	○	○	○

6. Do you use Blackboard for other purposes, such as 'community of practice', or storage of publications in content system, or ...?
(please answer strong but short)

7. *What is your opinion?*
The quality of my educational practice is improved by using the Blackboard VLE?

○ strongly disagree ○ disagree ○ neither agree nor disagree ○ agree ○ strongly agree ○ not applicable

8. Can you clarify your choice? *(please answer strong but short)*

9. Did you know that Blackboard Support could assist you in creating your video lectures?

○ yes ○ no

10. Did you consult Blackboard Support this academic year?

○ yes ➡ Ga verder met vraag 22. ○ no ○ not familiar with

About Blackboard Support:

1. How do you value the support?

○ very bad ○ bad ○ not good / not bad ○ good ○ very good ○ not applicable

2. Were you served quickly enough?

○ very bad ○ bad ○ not good / not bad ○ good ○ very good ○ not applicable

3. Were you served well enough?

○ very bad ○ bad ○ not good / not bad ○ good ○ very good ○ not applicable

4. Do you have extra demands concerning the Blackboard Support?
(please answer strong but short)

5. How do you value the training course?

○ very bad ○ bad ○ not good / not bad ○ good ○ very good ○ not applicable

6. Do you have extra demands concerning the training course?
(please answer strong but short)

Finally:

1. What ICT tool are you eager to use?
   (use comma seperated keywords)

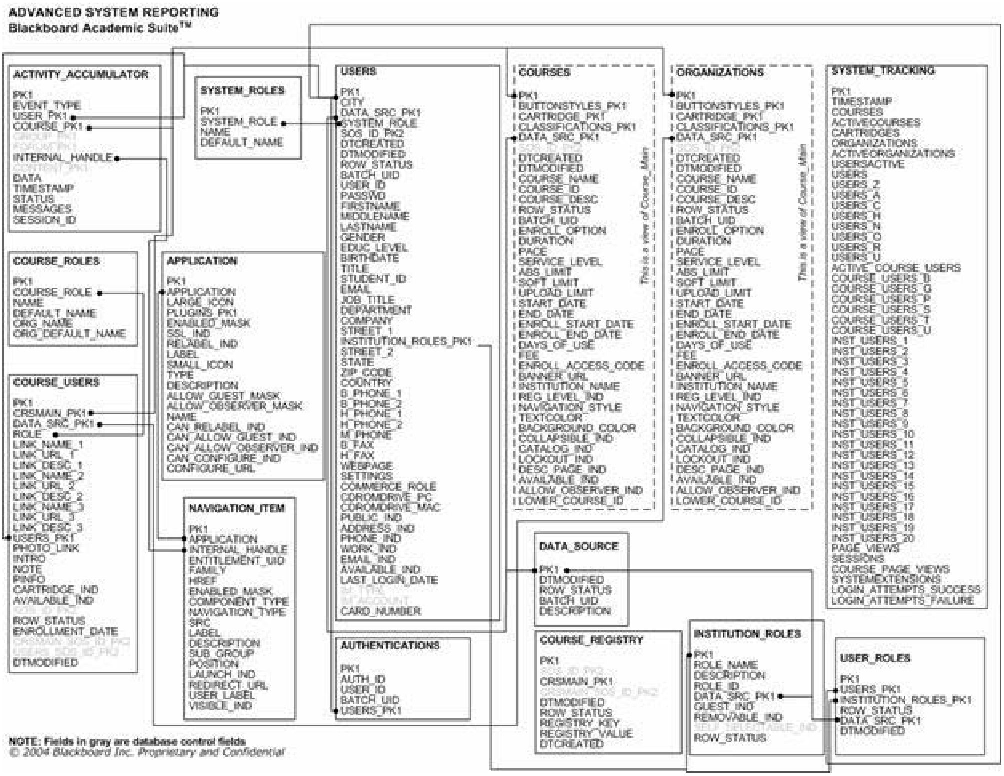
2. What ICT means do you detest most for future use in your educational practice?
   (use comma seperated keywords)

3. Can you clarify your choices concerning the former two questions?
   (please answer strong but short)

1. Please, indicate what other ICT tools you use.
   (use comma seperated keywords)

1. Please indicate how ICT came into you educational practice?
   (please answer strong but short)

12.3 APPENDIX C: ADVANCED SYSTEM REPORTING DATABASE



The diagram shown above details the shared rows in the reporting database tables. The relationship between the tables is used to define and return customized data reports.

The following tables detail the attributes in each database table. Each of the tables below includes the following columns:
***Attribute:** The name of the attribute as it appears in the database.*
***Data Type:** The format of the information stored in the attribute (date, varchar, etc.)*
***Null:** Indicated whether or not null values are allowed. Y indicates that null values are allowed for the attribute, N indicates that null values are not allowed for the attribute.*
***Description:** Explains the information stored in the attribute and its importance.*

ACTIVITY_ACCUMULATOR

Attribute	*Data Type and Constraints*	*Null?*	*Description*
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
EVENT_TYPE	VARCHAR (30)	N	Groups the event based on what occurred. Please see the Event Type table below for specific information on the possible values for this field.
USER_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the USERS table.
COURSE_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the COURSE table.
GROUP_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the GROUP table.
FORUM_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the FORUM table.

INTERNAL_HANDLE	VARCHAR (255)	Y	Internal system identifier for the event. This field corresponds to the unique ID in the NAVIGATION ITEM table. Not all page requests correspond to a navigation item, so this field may often appear blank. When reading the INTERNAL HANDLE, the prefix helps identify the path the user took to access the page. CP_ indicates that the user went through the Course Control Panel to view the page. PA_ is associated with portal administrator functions ADMIN refers to accesses through the Administrator Control Panel LIST indicates that the page was requested after a search function CUST_ refers to a Customization interface, such as the Customize Login Page If this field is empty, check the CONTENT PK1 field. If the page accessed displayed content, the primary key for the piece of content will appear in that field.
CONTENT_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the CONTENT table. This field is populated when the EVENT TYPE is CONTENT_ACCESS.
DATA	NVARCHAR (255)	Y	Data related to the event. This field provides additional information on the event. Each event uses this field, if at all, in different ways. In many instances, the data included in this field is a value that is easily deduced. In some instances, the value in the data field is a number, such as _1_1 or 29 1. These are associated with an EVENT_TYPE of TAB_ACCESS or MODULE_ACCESS. The first number is an ID that references a tab or a module (the second number can be ignored). The ID number that refers to a tab can be found in the user interface by scrolling over the tab. The ID number appears as part of the URL in the status bar. The ID number that refers to a module can be found in the same manner. Scroll over the Maximize, Minimize, or Edit button associated with a module. The ID number will appear as part of the URL in the status bar. Please note that the Detach Module button returns a different ID number and should be ignored.
TIMESTAMP	DATETIME (8)	Y	Date and time that the event occurred.
STATUS	NUMERIC (9)	Y	Shows success (1) and failure (0).
MESSAGES	NTEXT (16)	Y	Additional messages associated with the event.
SESSION_ID	INT (4)		Identifies the user session that initiated the action. A session is simply a browser connection to the system launched from an end-user machine.

Event Types

The following table lists the possible event types stored in the ACTIVITY_ACCUMULATOR table. The Page View column shows whether or not the activity counts as a page view when generating statistics.

Type	*Description*	*Page View?*
TAB_ACCESS	A browser request that causes a portal tab to change state. The name of the tab will be returned.	Yes
MODULE_ACCESS	Triggered when a portal module is rendered. The name of the module will be returned.	No
LOGIN_ATTEMPT	An attempt to authenticate to the system. Additional information on the success is stored.	No
LOGOUT	A users session is voluntarily ended by accessing the logout link.	No
SESSION_TIMEOUT	A users session is involuntarily ended because no action was taken in a specific window.	No
COURSE_ACCESS	Triggered when a course frameset is loaded, or when a page is accessed in a course. The name of the navigation item will be returned.	Yes
CONTENT_ACCESS	Triggered when content is displayed.	No
PAGE_ACCESS	Triggered when a page, other than a course, organization, content, module, or tab is accessed on the system. The name of the navigation item will be returned.	Yes
SESSION_INIT	Triggered when a session is initialized.	No

COURSE_ROLES

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
COURSE_ROLE	CHAR (1)	N	One character system identifier for a Course Role. B=Course Builder or Organization Builder G=Grader P=Instructor or Organization Leader S=Student or Organization Member T=Teaching Assistant U=Guest
NAME	NVARCHAR (50)	Y	Customized name of a Course Role.
DEFAULT_NAME	VARCHAR (50)	Y	Default name of a Course Role.
ORG_NAME	NVARCHAR (50)	Y	Customized name of an Organization Role.
ORG_DEFAULT_NAME	VARCHAR (50)	Y	Default name of an Organization Role.

COURSE_USERS

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
CRSMAIN_PK1	INT (4)	N	References the PK1 (Primary Key) attribute of the COURSE_MAIN table.
DATA_SRC_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the DATA_SOURCE table.
ROLE	CHAR (1)	Y	One character identifier of the users Course Role. B=Course Builder or Organization Builder G=Grader P=Instructor or Organization Leader S=Student or Organization Member T=Teaching Assistant U=Guest
LINK_NAME_1	NVARCHAR (100)	Y	Name of a link to a Web site listed on the Users Homepage within the course.
LINK_URL_1	VARCHAR (100)	Y	Address of a link on the Users Homepage.
LINK_DESC_1	NVARCHAR (255)	Y	Description of a link on the Users Homepage.
LINK_NAME_2	VARCHAR (100)	Y	Name of a link to a Web site listed on the Users Homepage within the course.
LINK_URL_2	VARCHAR (100)	Y	Address of a link on the Users Homepage.
LINK_DESC_2	NVARCHAR (255)	Y	Description of a link on the Users Homepage.
LINK_NAME_3	NVARCHAR (100)	Y	Name of a link to a Web site listed on the Users Homepage within the course.
LINK_URL_3	VARCHAR (100)	Y	Address of a link on the Users Homepage.
LINK_DESC_3	NVARCHAR (255)	Y	Description of a link on the Users Homepage.
USERS_PK1	INT (4)	N	References the PK1 (Primary Key) attribute of the USERS table.
PHOTO_LINK	VARCHAR (100)	Y	Link to a image that will display on the Users Homepage.
INTRO	NTEXT (16)	Y	Message that will display on the Users Homepage.
NOTE	NTEXT (16)	Y	Text box in the user interface filled out by the user.
PINFO	NTEXT (16)	Y	Message that will display on the Users Homepage, typically used to display personal information.
CARTRIDGE_IND	CHAR (1) Y or N	N	Determines whether or not the user can access cartridge content in the course.
AVAILABLE_IND	CHAR (1) Y or N	N	Determines whether or not the user can access the course.
SOS_ID_PK2	INT (4)	N	Not in use.
ROW_STATUS	NUMERIC (5)	Y	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the

			UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.
ENROLLMENT_DATE	DATETIME (8)	Y	Date the User enrolled in the Course.
CRSMAIN_SOS_ID_PK2	INT (4)	Y	Not in use.
USERS_SOS_ID_PK2	INT (4)	Y	Not in use.
DTMODIFIED	DATETIME (8)	Y	The last date the record was modified.

SYSTEM_ROLES

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
SYSTEM_ROLE	CHAR (1)	N	One character identifier for each System Role. Z=System Administrator A=User Administrator C=Course Administrator H=System Support N=None O=Observer R=Support U=Guest
NAME	NVARCHAR (64)	Y	The customized name of a System Role.
DEFAULT_NAME	VARCHAR (64)	Y	The name of a System Role as it appeared before modification.

INSTITUTION_ROLES

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
ROLE_NAME	NVARCHAR (50)	N	Name of an Institution Role as it appears to users.
DESCRIPTION	NVARCHAR (255)	Y	Description of the role.
ROLE_ID	NVARCHAR (50)	N	The unique identifier of the role. This is the key that is used to identify the role during Snapshot and other data management operations.
DATA_SRC_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the DATA_SOURCE table.
GUEST_IND	CHAR (1)	N	This indicates whether or not the role serves as a Guest role for a particular brand.
REMOVABLE_IND	CHAR (1)	N	This indicates whether or not the role may be removed from the system. Some institution roles are not removable to ensure backward compatibility.
SELF_SELECTABLE_IND	CHAR (1)	N	This field is not currently used to store data.
ROW_STATUS	INT (4)	N	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.

USER_ROLES

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
USERS_PK1	INT (4)	N	The primary key that identifies a user in the USERS table.
INSTITUTION_ROLES_PK1	INT (4)	N	The primary key that identifies an Institution Role in the INSTITUTION_ROLES table.
ROW_STATUS	NUMERIC (5)	Y	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.

DATA_SRC_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the DATA_SOURCE table.
DTMODIFIED	DATETIME (8)	Y	The date the relationship between the user and the Institution Role was last modified.

APPLICATION

Applications are the tools and features that appear in the Blackboard Learning System.

Attribute	Data Type and Constraints	Null ?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
APPLICATION	VARCHAR (64)	N	Internal system identifier.
LARGE_ICON	VARCHAR (255)	Y	Location of the image to display with the application if large icons are used.
PLUGINS_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the PLUGINS table.
ENABLED_MASK	INT (4)	Y	Determines whether or not the tool is enabled.
SSL_IND	CHAR (1) Y or N	N	Displays whether or not SSL is enabled for the application.
RELABEL_IND	CHAR (1) Y or N	N	Displays whether or not the application can be renamed.
LABEL	NVARCHAR (255)	Y	Name of the application as it appears in the user interface.
SMALL_ICON	VARCHAR (255)	Y	Location of the image to display with the application if small icons are used.
TYPE	VARCHAR (20)	Y	Defines the application as a Course application, System (Portal) application, or Shared application.
DESCRIPTION	NTEXT (16)	Y	A description of the application.
ALLOW_GUEST_MASK	INT (4)	Y	Determines whether or not Guests can access.
ALLOW_OBSERVER_MASK	INT (4)	Y	Determines whether or not Observers can access the application.
NAME	NVARCHAR (64)	Y	This field displays the name of the function or tool.
CAN_RELABEL_IND	CHAR (1) Y or N	Y	Determines whether or not the name of the application can be changed by an Instructor or Administrator.
CAN_ALLOW_GUEST_IND	CHAR (1) Y or N	Y	Determines whether or not the Instructor can control Guest access to the feature or tool.
CAN_ALLOW_OBSERVER_IND	CHAR (1) Y or N	Y	Determines whether or not the Instructor can control Observer access to the feature or tool.
CAN_CONFIGURE_IND	CHAR (1) Y or N	Y	Signifies if the tool is configured through an outside Web site. This only applies to Building Blocks tools.
CONFIGURE_URL	VARCHAR (1000)	Y	The URL used to configure the tool.

NAVIGATION_ITEM

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
APPLICATION	NVARCHAR (64)	Y	Application accessed through the navigation item
INTERNAL_HANDLE	VARCHAR (255)	N	Unique identifier.
ENTITLEMENT_UID	VARCHAR (255)	Y	Defines the entitlement required to access the item.
FAMILY	VARCHAR (255)	Y	Top level for groupings of navigation items.
HREF	VARCHAR (2550	Y	Address of the application in the file system.
ENABLED_MASK	INT (4)	Y	Determines if the item is enabled in a course, the system, or an organization.
COMPONENT_TYPE	VARCHAR (20)	Y	Groups items under the Sub-Group heading.
NAVIGATION_TYPE	VARCHAR (20)	Y	Course or System Determines whether the navigation item is available in courses or through the portal.
SRC	VARCHAR (255)	Y	Image or icon connected to the navigation item.
LABEL	VARCHAR (255)	Y	Name of the navigation item as it appears within

			the system.
DESCRIPTION	VARCHAR (3900)	Y	Description of the navigation item as it appears in the system.
SUB_GROUP	VARCHAR (255)	Y	Groups navigation items under the Family heading.
POSITION	INT (4)	Y	Order that the navigation item appears in the system in relation to other items in the same grouping.
LAUNCH_IND	CHAR (1) Y or N	Y	Determines whether or not to launch the application in a separate browser window.
REDIRECT_URL	VARCHAR (255)	Y	Some navigation items, such as the Lost Password page, may be redirected. If allowed, the redirected URL appears in this field.
USER_LABEL	NVARCHAR (255)	Y	Customized label.
VISIBLE_IND	CHAR (1)	Y	Determines whether or not the item is visible to users.

USERS

Attribute	*Data Type and Constraints*	*Null?*	*Description*
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
CITY	NVARCHAR (50)	Y	City of the users address.
DATA_SRC_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the DATA_SOURCE table.
SYSTEM_ROLE	CHAR (1)	N	One character identifier of the Administrator Role assigned to the User. Z=System Administrator A=User Administrator C=Course Administrator H=System Support N=None O=Observer R=Support U=Guest
SOS_ID_PK2	INT (4)	N	Not in use.
DTCREATED	DATETIME (8)	N	Date the user was created in the system.
DTMODIFIED	DATETIME (8)	Y	Last date that the user record was modified in the system.
ROW_STATUS	NUMERIC (5)	N	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.
BATCH_UID	NVARCHAR (64)	Y	Unique identifier within the database.
USER_ID	NVARCHAR (50)	N	Username.
PASSWD	VARCHAR (32)	N	The users password.
FIRSTNAME	NVARCHAR (100)	N	The first name of the user.
MIDDLENAME	NVARCHAR (100)	Y	The middle name of the user.
LASTNAME	NVARCHAR (100)	N	The last name of the user.
GENDER	CHAR (1) F or M	Y	The sex of the user.
EDUC_LEVEL	NUMERIC (5)	Y	Highest level of education achieved by the user.
BIRTHDATE	DATETIME (8)	Y	The users birth date.
TITLE	NVARCHAR (100)	Y	A title in the users name (for example, Mr. or Dr.).
STUDENT_ID	NVARCHAR (100)	Y	Users Student ID as assigned by the institution. Uniqueness is not enforced on this field, it is used to store information only.
EMAIL	VARCHAR (100)	Y	The Users email address.
JOB_TITLE	NVARCHAR (100)	Y	The users job title.
DEPARTMENT	NVARCHAR (100)	Y	Department, section, or area where the User works.
COMPANY	NVARCHAR (100)	Y	Company for which the user works.
STREET_1	NVARCHAR (100)	Y	Street in the users address.
INSTITUTION_ROLES_PK1	INT (4)	N	References the PK1 (Primary Key) attribute of the INSTITUTION_ROLES table.

STREET_2	NVARCHAR (100)	Y	Another line for Street in the users address.
STATE	NVARCHAR (50)	Y	State in the users address.
ZIP_CODE	NVARCHAR (50)	Y	ZIP code in the Users address.
COUNTRY	NVARCHAR (50)	Y	Country in the Users address.
B_PHONE_1	NVARCHAR (50)	Y	The users business phone number.
B_PHONE_2	NVARCHAR (50)	Y	A second line for another business phone number.
H_PHONE_1	NVARCHAR (50)	Y	The Users home phone number.
H_PHONE_2	NVARCHAR (50)	Y	A second line for another home phone number.
M_PHONE	NVARCHAR (50)	Y	The users mobile phone number.
B_FAX	NVARCHAR (50)	Y	The users business fax number.
H_FAX	NVARCHAR (50)	Y	The users home fax number.
WEBPAGE	VARCHAR (100)	Y	The URL for the Users Web page.
SETTINGS	NTEXT (16)	Y	text box with info about the user.
COMMERCE_ROLE	INT (4)	Y	This field relates to a Blackboard.com value. It is only relevant in the context of Blackboard.com.
CDROMDRIVE_PC	CHAR (1)	Y	One character identifying the drive of the CD-ROM drive on the users personal computer.
CDROMDRIVE_MAC	NVARCHAR (20)	Y	Name of the CD-ROM drive on the users computer, if using an Apple Macintosh.
PUBLIC_IND	CHAR (1) Y or N	N	Determines whether or not the users personal information is displayed in the User Directory.
ADDRESS_IND	CHAR (1) Y or N	N	Determines if the users home address will be displayed in the User Directory.
PHONE_IND	CHAR (1) Y or N	N	Determines if home phone, fax, or cell phone numbers will be displayed in the User Directory.
WORK_IND	CHAR (1) Y or N	N	Determines if work contact information (company, department, title, phone, fax) will be displayed in the User Directory.
EMAIL_IND	CHAR (1) Y or N	N	Determines if the users email address will be displayed in the User Directory.
AVAILABLE_IND	CHAR (1) Y or N	N	User account availability within the system.
LAST_LOGIN_DATE	DATETIME (8)	Y	Last date that the user logged into the system.
IM_TYPE	NVARCHAR (64)	Y	This field is not used to store data.
IM_ACCOUNT	NVARCHAR (64)	Y	This field is not used to store data.
CARD_NUMBER	VARCHAR (100)	Y	The card number associated with the user's Blackboard Transaction System Campus Card.

COURSE_MAIN

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (1)	N	Unique identifier for each record. (Primary Key)
BUTTONSTYLES_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the BUTTONSTYLES table.
CARTRIDGE_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the CARTRIDGE table.
CLASSIFICATIONS_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the CLASSIFICATIONS table.
DATA_SRC_PK1	INT (4)	Y	References the PK1 (Primary Key) attribute of the DATA_SOURCE table.
SOS_ID_PK2	INT (4)	Y	Not in use.
DTCREATED	DATETIME (8)	N	Date the Course was created in the system.
DTMODIFIED	DATETIME (8)	Y	Last date that the Course was modified in the system.
COURSE_NAME	NVARCHAR (255)	N	Complete title of the course.
COURSE_ID	VARCHAR (50)	N	Short name used by the institution to uniquely identify the course (for example, math101 _F99).
COURSE_DESC	NTEXT(16)	Y	Complete description of the course.
ROW_STATUS	NUMERIC (5)	Y	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.
BATCH_UID	NVARCHAR (64)	Y	Unique identifier.

ENROLL_OPTION	CHAR (1) E,I, or S	Y	Establishes the enrollment policy for the course. The options are email request for enrollment, self-enroll for Students to enroll themselves, and instructor-enroll to allow Instructors to completely control enrollment.
DURATION	CHAR (1)	Y	Schedules enrollment window. Options are: Continuous: The Course is always accessible. Range: The Course is accessible in the days between one date and another. Either the beginning date or the end date can be left open-ended to make a course accessible from a certain date or until a certain date. Fixed: The Course is accessible for a set number of days.
PACE	CHAR (1) S, or I	Y	Indicates if the course is instructor-led or self-paced according to the student.
SERVICE_LEVEL	CHAR (1)	Y	determines course or organization.
ABS_LIMIT	NUMERIC (9)	Y	Handles the disk quota absolute limit on content. The content in the course may not exceed this limit. Expressed in bytes.
SOFT_LIMIT	NUMERIC (9)	Y	Handles the disk quota soft limit on content. Instructors receive a warning email when this limit is exceeded. Expressed in bytes.
UPLOAD_LIMIT	NUMERIC (9)	Y	Handles the disk quota limit on uploads. Expressed in bytes.
START_DATE	DATETIME (8)	Y	Date on which access to the course section begins.
END_DATE	DATETIME (8)	Y	Date on which access to the course ends.
ENROLL_START_DATE	DATETIME (8)	Y	Date that enrollment may begin.
ENROLL_END_DATE	DATETIME (8)	Y	Date that enrollment is no longer available to Students.
DAYS_OF_USE	NUMERIC (5)	Y	Number of days that Students may access the course after enrollment. Useful for self-paced learning.
FEE	NUMERIC (9)	Y	Fee for the course.
ENROLL_ACCESS_CODE	NVARCHAR (50)	Y	Password needed to enroll in the course.
BANNER_URL	VARCHAR (100)	Y	Link to an image that will display at the top of the course.
INSTITUTION_NAME	NVARCHAR (255)	Y	The name of the institution.
REG_LEVEL_IND	CHAR (1) Y or N	N	This field is used for the Blackboard.com service. It has not relevance outside of the Blackboard.com site.
NAVIGATION_STYLE	VARCHAR (20)	Y	Determines whether the Course Menu uses buttons or text links.
TEXTCOLOR	VARCHAR (20)	Y	Colour used for text in the Course Menu.
BACKGROUND_COLOR	VARCHAR (20)	Y	Colour used for the background of the Course Menu.
COLLAPSIBLE_IND	CHAR (1)	N	Determines whether or not the Course Menu can be consolidated to show just the top headings or expanded to show subheads.
ALLOW_GUEST_IND	CHAR (1) Y or N	N	Allows guest access to the course.
CATALOG_IND	CHAR (1) Y or N	N	Establishes whether the course or organization appears in catalogue.
LOCKOUT_IND	CHAR (1) Y or N	N	Indicates if access to the course or organization has been restricted. If set to Y access to the course or organization will be restricted based on the END_DATE and START_DATE.
DESC_PAGE_IND	CHAR (1) Y or N	N	Determines whether or not to display description information in the course or organization catalogue.
AVAILABLE_IND	CHAR (1) Y or N	N	Establishes course or organization availability.
ALLOW_OBSERVER_IND	CHAR (1) Y or N	N	Determines whether or not Observers are allowed in the course.
LOWER_COURSE_ID	VARCHAR (50)	Y	Lowercase version of course id used by the system for searches (guarantee a find).

DATA_SOURCE

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
DTMODIFIED	DATETIME (8)	Y	The date the data source was last modified.
ROW_STATUS	NUMERIC (5)	N	Sets the value of the record to one of the following: Enabled: Normal access to the record. Disabled: Record is visible in some areas of the UI, but may not be changed or accessed. Deleted: Record is scheduled to be removed.
BATCH_UID	NVARCHAR (64)	Y	Unique identifier.
DESCRIPTION	NVARCHAR (128)	Y	Description of the data source.

SYSTEM_TRACKING

Attribute	Data Type and Constraints	Null?	Description
PK1	INT (4)	N	Unique identifier for each record. (Primary Key)
TIMESTAMP	DATETIME (8)	Y	Date and time that the statistics were gathered.
COURSES	NUMERIC (9)	Y	Total number of courses in the system.
ACTIVECOURSES	NUMERIC (9)	Y	Total number of active courses in the system. An active course is one that has been accessed in the last 30 days.
CARTRIDGES	NUMERIC (9)	Y	Total number of Course Cartridges used in the system.
ORGANIZATIONS	NUMERIC (9)	Y	Total number of organizations in the system.
ACTIVEORGANIZATIONS	NUMERIC (9)	Y	Total number of active organizations in the system.
ACTIVEUSERS	NUMERIC (9)	Y	Total number of active users in the system. An active user has accessed the system within the last 30 days. Users disabled through the Snapshot tool are still considered active if he or she has accessed the course in the last 30 days.
USERS	NUMERIC (9)	Y	Total number of users in the system.
USERS_Z	NUMERIC (9)	Y	Total number of users with an Administrative User Role of Z (default name: System Admin).
USERS_A	NUMERIC (9)	Y	Total number of users with an Administrative User Role of A (default name: User Administrator).
USERS_C	NUMERIC (9)	Y	Total number of users with an Administrative User Role of C (default name: Course Administrator).
USERS_H	NUMERIC (9)	Y	Total number of users with an Administrative User Role of H (default name: System Support).
USERS_N	NUMERIC (9)	Y	Total number of users with an Administrative User Role of N (default name: None).
USERS_O	NUMERIC (9)	Y	Total number of users with an Administrative User Role of O (default name: Observer).
USERS_R	NUMERIC (9)	Y	Total number of users with an Administrative User Role of R (default name: Support).
USERS_U	NUMERIC (9)	Y	Total number of users with an Administrative User Role of U (default name: Guest).
ACTIVE_COURSE_USERS	NUMERIC (9)	Y	Total number of active users (includes enrollments as well as staff assignments). Active course users are those enrolled users that have accessed the course in the past 30 days.
COURSE_USERS_B	NUMERIC (9)	Y	Total number of users with a Course Role of B (default name: Course Builder).
COURSE_USERS_G	NUMERIC (9)	Y	Total number of users with a Course Role of G (default name: Grader).
COURSE_USERS_P	NUMERIC (9)	Y	Total number of users with a Course Role of P (default name: Instructor).
COURSE_USERS_S	NUMERIC (9)	Y	Total number of users with a Course Role of S (default name: Student).
COURSE_USERS_T	NUMERIC (9)	Y	Total number of users with a Course Role of T (default name: Teachers Assistant).

COURSE_USERS_U	NUMERIC (9)	Y	Total number of users with a Course Role of U (default name: Guest).
INST_USERS_1	NUMERIC (9)	Y	Total number of users with an Institution Role of 1 (default name: Student).
INST_USERS_2	NUMERIC (9)	Y	Total number of users with an Institution Role of 2 (default name: Faculty).
INST_USERS_3	NUMERIC (9)	Y	Total number of users with an Institution Role of 3 (default name: Staff).
INST_USERS_4	NUMERIC (9)	Y	Total number of users with an Institution Role of 4 (default name: Alumni).
INST_USERS_5	NUMERIC (9)	Y	Total number of users with an Institution Role of 5 (default name: Prospective Student).
INST_USERS_6	NUMERIC (9)	Y	Total number of users with an Institution Role of 6 (default name: Guest).
INST_USERS_7	NUMERIC (9)	Y	Total number of users with an Institution Role of 7 (default name: Other).
INST_USERS_8	NUMERIC (9)	Y	Total number of users with an Institution Role of 8 (default name: Observer).
INST_USERS_9	NUMERIC (9)	Y	Total number of users with an Institution Role of 9 (default name: Role 9).
INST_USERS_10	NUMERIC (9)	Y	Total number of users with an Institution Role of 10 (default name: Role 10).
INST_USERS_11	NUMERIC (9)	Y	Total number of users with an Institution Role of 11 (default name: Role 11).
INST_USERS_12	NUMERIC (9)	Y	Total number of users with an Institution Role of 12 (default name: Role 12).
INST_USERS_13	NUMERIC (9)	Y	Total number of users with an Institution Role of 13 (default name: Role 13).
INST_USERS_14	NUMERIC (9)	Y	Total number of users with an Institution Role of 14 (default name: Role 14).
INST_USERS_15	NUMERIC (9)	Y	Total number of users with an Institution Role of 15 (default name: Role 15).
INST_USERS_16	NUMERIC (9)	Y	Total number of users with an Institution Role of 16 (default name: Role 16).
INST_USERS_17	NUMERIC (9)	Y	Total number of users with an Institution Role of 17 (default name: Role 17).
INST_USERS_18	NUMERIC (9)	Y	Total number of users with an Institution Role of 18 (default name: Role 18).
INST_USERS_19	NUMERIC (9)	Y	Total number of users with an Institution Role of 19 (default name: Role 19).
INST_USERS_20	NUMERIC (9)	Y	Total number of users with an Institution Role of 20 (default name: Role 20).
PAGE_VIEWS	NUMERIC (9)	Y	Total number of page views to date. A page view is any request for a page that occurs outside of a course or organization.
SESSIONS	NUMERIC (9)	Y	Number of open sessions.
COURSE_PAGE_VIEWS	NUMERIC (9)	Y	Total number of course page views to date. A course page view is a request for a page that occurs within a course or an organization.
SYSTEMEXTENSIONS	NUMERIC (9)	Y	Total number of Building Blocks.
LOGIN_ATTEMPTS_SUCCESS	NUMERIC (9)	Y	Total number of successful login attempts.
LOGIN_ATTEMPTS_FAILURE	NUMERIC (9)	Y	Total number of failed login attempts.

12.4 Appendix D: 402 Internal handles of BB_BB60_STATS. NAVIGATION_ITEM

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
1	(null)	account_on_gateway	gateway_options	299
2	(null)	add_link_tab	pa_manage_tabs	350
3	(null)	add_module_tab	pa_manage_tabs	348
4	(null)	add_tool_tab	pa_manage_tabs	349
5	(null)	admin_club_club_categories	categorize_clubs	129
6	(null)	admin_club_club_properties	admin_club_properties	34
7	(null)	admin_club_enable_tools	comm_settings	136
8	(null)	admin_club_properties	list_clubs	314
9	(null)	admin_club_quickedit	comm_settings	386
10	(null)	admin_course_button_style	admin_course_course_images	35
11	(null)	admin_course_course_availability	admin_course_options	41
12	(null)	admin_course_course_banner	admin_course_course_images	36
13	(null)	admin_course_course_categories	admin_course_properties	51
14	(null)	admin_course_course_duration	admin_course_options	43
15	(null)	admin_course_course_exporter	admin_course_course_utilities	38
16	(null)	admin_course_course_images	admin_course_properties	53
17	(null)	admin_course_course_properties	admin_course_properties	49
18	(null)	admin_course_course_quotas	admin_course_properties	50
19	(null)	admin_course_course_recycler	admin_course_course_utilities	37
20	(null)	admin_course_course_utilities	admin_course_properties	52
21	(null)	admin_course_enable_tools	course_settings	202
22	(null)	admin_course_enrollment_fees	admin_course_options	45
23	(null)	admin_course_enrollment_options	admin_course_options	44
24	(null)	admin_course_guest_access	admin_course_options	42
25	(null)	admin_course_list_users	admin_course_properties	47
26	(null)	admin_course_options	admin_course_properties	40
27	(null)	admin_course_properties	list_courses	315
28	(null)	admin_course_quickedit	course_settings	387
29	(null)	admin_course_statistics	admin_course_properties	54
30	(null)	admin_course_template_option	admin_course_properties	421
31	(null)	admin_logfiles	admin_main	101
32	(null)	admin_main	0	1
33	(null)	admin_modify_user_in_course	admin_course_list_users	39
34	(null)	admin_plugin_download	admin_plugin_manage	69
35	(null)	admin_plugin_install	admin_plugin_manage	73
36	(null)	admin_plugin_manage	admin_main	60
37	(null)	archive_club	admin_main	115
38	(null)	archive_course	admin_main	111
39	(null)	authentication_config	admin_main	68
40	(null)	auto_reports	system_statistics	379
41	(null)	batch_create_comm	admin_main	71
42	(null)	batch_create_courses	admin_main	70
43	(null)	batch_create_users	admin_main	72
44	(null)	batch_remove_users	admin_main	85
45	(null)	cart_import	admin_logfiles	106
46	(null)	categorize_clubs	club_catalog	130
47	(null)	categorize_courses	course_catalog	196
48	(null)	classic_club_catalog	0	3
49	(null)	classic_course_catalog	0	4
50	(null)	club_catalog	admin_main	124
51	(null)	club_props_areas	comm_settings	135
52	(null)	club_props_defaults	comm_settings	133
53	(null)	club_props_design	comm_settings	134
54	(null)	comm_discussion	lf_community	312
55	(null)	comm_images	admin_main	122
56	(null)	comm_select_icons	comm_images	302
57	(null)	comm_set_course_images	comm_images	301
58	(null)	comm_settings	admin_main	121
59	(null)	config_logfiles	admin_logfiles	105
60	(null)	control_panel	0	8
61	(null)	control_panel_link	course_admin_button	191
62	(null)	copy_club	admin_main	94
63	(null)	copy_course	admin_main	90
64	(null)	copy_course_content_exact	copy_course	93
65	(null)	copy_course_content_exists	copy_course	92
66	(null)	copy_course_content_new	copy_course	91
67	(null)	copy_org_content_exact	copy_club	97

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
68	(null)	copy_org_content_exists	copy_club	96
69	(null)	copy_org_content_new	copy_club	95
70	(null)	course_catalog	admin_main	123
71	(null)	course_creation_wizard	admin_main	422
72	(null)	course_disk_quotas	course_settings	375
73	(null)	course_images	admin_main	120
74	(null)	course_props_areas	course_settings	201
75	(null)	course_props_defaults	course_settings	199
76	(null)	course_props_design	course_settings	200
77	(null)	course_role_rename	course_settings	117
78	(null)	course_select_icons	course_images	304
79	(null)	course_set_course_images	course_images	303
80	(null)	course_settings	admin_main	118
81	(null)	course_top	0	9
82	(null)	coursemap	course_admin_button	190
83	(null)	cp_add_users_batch	control_panel	161
84	(null)	cp_add_users_create	control_panel	158
85	(null)	cp_add_users_enroll	control_panel	166
86	(null)	cp_assessment_add_category	cp_assessment_manager	215
87	(null)	cp_assessment_add_qstns	cp_assessment_manager	216
88	(null)	cp_assessment_attach_file	cp_assessment_manager	217
89	(null)	cp_assessment_builder	cp_assessment_manager	218
90	(null)	cp_assessment_create	cp_assessment_manager	219
91	(null)	cp_assessment_preview	cp_assessment_manager	220
92	(null)	cp_assessment_set_availability	cp_assessment_manager	221
93	(null)	cp_contact_sys_admin	control_panel	164
94	(null)	cp_copy_course	control_panel	178
95	(null)	cp_copy_course_content_exact	cp_copy_course	184
96	(null)	cp_copy_course_content_exists	cp_copy_course	185
97	(null)	cp_copy_course_content_new	cp_copy_course	186
98	(null)	cp_copy_org_content_exact	cp_copy_course	187
99	(null)	cp_copy_org_content_exists	cp_copy_course	188
100	(null)	cp_copy_org_content_new	cp_copy_course	189
101	(null)	cp_course_classify	cp_course_options	236
102	(null)	cp_course_entry_point	cp_course_options	237
103	(null)	cp_course_export	control_panel	181
104	(null)	cp_course_images	cp_course_options	238
105	(null)	cp_course_images_banner	cp_course_images	229
106	(null)	cp_course_images_button	cp_course_images	228
107	(null)	cp_course_options	control_panel	176
108	(null)	cp_course_options_area	control_panel	174
109	(null)	cp_course_options_avail	cp_course_options	231
110	(null)	cp_course_options_dur	cp_course_options	233
111	(null)	cp_course_options_enroll	cp_course_options	234
112	(null)	cp_course_options_fee	cp_course_options	235
113	(null)	cp_course_properties	cp_course_options	230
114	(null)	cp_course_role_modify	cp_list_modify_users	273
115	(null)	cp_course_statistics	control_panel	169
116	(null)	cp_course_utilities_cartridge_add	control_panel	179
117	(null)	cp_course_utilities_export	control_panel	182
118	(null)	cp_course_utilities_recycler	control_panel	177
119	(null)	cp_list_modify_users	control_panel	153
120	(null)	cp_manage_tools	control_panel	175
121	(null)	cp_modify_user	cp_list_modify_users	271
122	(null)	cp_online_manual	control_panel	160
123	(null)	cp_online_support	control_panel	155
124	(null)	cp_options_guest	cp_course_options	232
125	(null)	cp_options_observer	cp_course_options	239
126	(null)	cp_package_import	control_panel	180
127	(null)	cp_password_modify	cp_list_modify_users	272
128	(null)	cp_pool_add_category	cp_pool_manager	284
129	(null)	cp_pool_add_qstns	cp_pool_manager	285
130	(null)	cp_pool_attach_file	cp_pool_manager	286
131	(null)	cp_pool_create	cp_pool_manager	283
132	(null)	cp_pool_export	cp_pool_manager	288
133	(null)	cp_pool_import	cp_pool_manager	287
134	(null)	cp_pool_manager	control_panel	163
135	(null)	cp_remove_users	control_panel	170
136	(null)	cp_survey_create	cp_assessment_manager	222
137	(null)	cp_survey_manager	control_panel	159
138	(null)	cp_survey_preview	cp_assessment_manager	223
139	(null)	cp_test_manager	control_panel	154
140	(null)	cp_tools_enable_bb	cp_manage_tools	280
141	(null)	cp_tools_enable_content	cp_manage_tools	282

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
142	(null)	cp_tools_enable_ext	cp_manage_tools	281
143	(null)	create_club	admin_main	62
144	(null)	create_course	admin_main	63
145	(null)	create_user	admin_main	64
146	(null)	cust_classic_club_catalog	club_catalog	132
147	(null)	cust_classic_course_catalog	course_catalog	198
148	(null)	cust_courses	course_tab	204
149	(null)	cust_login_page	admin_main	88
150	(null)	cust_user_profile	admin_main	100
151	(null)	custom_reports	system_statistics	378
152	(null)	customize_portal	images_themes	305
153	(null)	email_all_system_instructors	inst_email	306
154	(null)	email_all_system_students	inst_email	307
155	(null)	email_all_system_users	inst_email	308
156	(null)	email_contact	admin_main	311
157	(null)	en_academic	academic_web_tab	26
158	(null)	en_club_creation	comm_settings	137
159	(null)	en_course_creation	course_settings	203
160	(null)	enroll_accept	0	12
161	(null)	enroll_course	0	13
162	(null)	enroll_user	0	14
163	(null)	event_queue_log	admin_logfiles	107
164	(null)	export_club	admin_main	114
165	(null)	export_course	admin_main	110
166	(null)	frame_options	pa_settings	358
167	(null)	gateway_options	admin_main	353
168	(null)	import_club	admin_main	112
169	(null)	import_course	admin_main	108
170	(null)	inst_email	admin_main	77
171	(null)	institution_properties	admin_main	89
172	(null)	integration_passwd	admin_main	82
173	(null)	jspell	admin_main	388
174	(null)	link_logfiles	admin_logfiles	104
175	(null)	list_clubs	admin_main	55
176	(null)	list_courses	admin_main	56
177	(null)	list_users	admin_main	57
178	(null)	login_key	admin_main	74
179	(null)	mail_logfiles	admin_logfiles	103
180	(null)	manage_boards	admin_main	99
181	(null)	manage_club_catalog	club_catalog	131
182	(null)	manage_course_catalog	course_catalog	197
183	(null)	message_options	admin_main	427
184	(null)	messages_tool_options	message_options	428
185	(null)	modify_tab	pa_manage_tabs	351
186	(null)	modify_tab_left_side	modify_tab	330
187	(null)	modify_tab_links	modify_tab	331
188	(null)	modify_tab_module_content	modify_tab	327
189	(null)	modify_tab_module_layout	modify_tab	328
190	(null)	modify_tab_properties	modify_tab	326
191	(null)	modify_tab_role_preview	modify_tab	329
192	(null)	modify_tab_services	modify_tab	333
193	(null)	modify_tab_sponsors	modify_tab	332
194	(null)	my_ab_add_contact	my_addressbook	334
195	(null)	my_ab_modify_contact	my_addressbook	335
196	(null)	my_ab_remove_contact	my_addressbook	336
197	(null)	new_account	0	15
198	(null)	oc_communities	community_tab	150
199	(null)	oc_learning	course_tab	205
200	(null)	online_admin	admin_main	67
201	(null)	online_support	admin_main	76
202	(null)	org_disk_quotas	comm_settings	376
203	(null)	org_role_rename	comm_settings	119
204	(null)	pa_edit_roles	pa_settings	360
205	(null)	pa_export_modules	admin_main	361
206	(null)	pa_links_sponsorships	pa_settings	359
207	(null)	pa_manage_channels	admin_main	75
208	(null)	pa_manage_hot_links	pa_settings	354
209	(null)	pa_manage_modules	admin_main	66
210	(null)	pa_manage_tabs	admin_main	61
211	(null)	pa_manage_toolbar	admin_main	81
212	(null)	pa_settings	admin_main	83
213	(null)	pa_settings_theme	pa_settings	355
214	(null)	pa_settings_top_frame	pa_settings	352
215	(null)	portal_delegated_admin	0	16

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
216	(null)	primary_sponsor	pa_settings	356
217	(null)	quick_enroll	course_admin_button	192
218	(null)	quick_unenroll	course_admin_button	193
219	(null)	registration_info	institution_properties	310
220	(null)	remove_clubs	admin_main	86
221	(null)	remove_course	admin_main	87
222	(null)	remove_user	admin_main	80
223	(null)	replace_top_frame	pa_settings	357
224	(null)	restore_club	admin_main	113
225	(null)	restore_course	admin_main	109
226	(null)	search_communities	lf_community	148
227	(null)	search_courses	lf_courses	147
228	(null)	send_stats	system_statistics	380
229	(null)	ssl_choice	admin_main	58
230	(null)	system_info	institution_properties	309
231	(null)	system_reports	system_statistics	377
232	(null)	system_settings	admin_main	102
233	(null)	system_statistics	admin_main	84
234	(null)	texteditor	admin_main	389
235	(null)	user_create_club	0	149
236	(null)	user_create_course	0	313
237	(null)	user_create_db	0	146
238	(null)	user_directory	0	23
239	(null)	user_management_links	admin_main	116
240	(null)	vinst_admin_profile	vinst_main	383
241	(null)	vinst_main	0	381
242	(null)	vinst_manage	vinst_main	382
243	academic_resources	lf_academic	lower_frame	324
244	address_book	ab_add_contact	address_book	27
245	address_book	ab_modify_contact	address_book	28
246	address_book	ab_remove_contact	address_book	29
247	address_book	address_book	course_tools_area	214
248	address_book	my_addressbook	0	24
249	admin	lf_enter_admin	lower_frame	325
250	announcements	announcements	communication	138
251	announcements	announcements_entry	course_top	139
252	announcements	cp_announcements	control_panel	151
253	announcements	inst_announcements	admin_main	59
254	announcements	my_announcements	0	2
255	bb-glossary	glossary	course_tools_area	423
256	bb-glossary	glossary_manager	control_panel	424
257	calendar	course_calendar	course_tools_area	209
258	calendar	cp_course_calendar	control_panel	152
259	calendar	inst_calendar	admin_main	65
260	calendar	my_inst_calendar	0	18
261	collaboration	collaboration	communication	141
262	collaboration	cp_collaboration	control_panel	171
263	community	community_pages	0	5
264	community	lf_community	lower_frame	322
265	content	content	0	6
266	content	cp_content	control_panel	7
267	content	cp_content_avail	cp_content	225
268	content	cp_content_metadata	cp_content	227
269	content	cp_content_properties	cp_content	224
270	content	cp_content_quickdisplay	course_top	385
271	content	cp_content_quickedit	course_top	384
272	content	cp_content_tracking	cp_content	226
273	course_communications	communication	0	10
274	course_email	cp_send_email	control_panel	162
275	course_email	cp_send_email_all_groups	cp_send_email	290
276	course_email	cp_send_email_all_instructors	cp_send_email	292
277	course_email	cp_send_email_all_observers	cp_send_email	295
278	course_email	cp_send_email_all_ta	cp_send_email	291
279	course_email	cp_send_email_all_users	cp_send_email	289
280	course_email	cp_send_email_select_groups	cp_send_email	294
281	course_email	cp_send_email_select_observers	cp_send_email	296
282	course_email	cp_send_email_select_students	cp_send_email	293
283	course_email	email_all_groups	send_email	368
284	course_email	email_all_instructors	send_email	370
285	course_email	email_all_observers	send_email	373
286	course_email	email_all_ta	send_email	369
287	course_email	email_all_users	send_email	367
288	course_email	email_select_groups	send_email	372
289	course_email	email_select_observers	send_email	374

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
290	course_email	email_select_students	send_email	371
291	course_email	my_email_courses	0	22
292	course_email	send_email	communication	140
293	course_roster	student_roster	communication	142
294	course_tools_area	course_tools_area	0	11
295	courses	lf_courses	lower_frame	321
296	discussion_board	cp_discussion_board	control_panel	165
297	discussion_board	db_message	discussion_board	297
298	discussion_board	db_post_message	discussion_board	298
299	discussion_board	discussion_board	communication	145
300	discussion_board	discussion_board_entry	course_top	144
301	dropbox	cp_digital_dropbox	control_panel	172
302	dropbox	drop_box	course_tools_area	206
303	dto-emerge-tools	dto-emerge-tools-nav-1	control_panel	399
304	dto-emerge-tools	dto-emerge-tools-nav-2	admin_main	400
305	dto-emerge-tools	dto-emerge-tools-nav-3	course_tools_area	401
306	edit_homepage	edit_homepage	course_tools_area	207
307	electric_blackboard	electric_blackboard	course_tools_area	213
308	FSU-adv-grp-mgmt	FSU-adv-grp-mgmt-nav-1	control_panel	395
309	groups	agroup	groups	300
310	groups	cp_add_group	cp_manage_groups	278
311	groups	cp_manage_group	cp_manage_groups	279
312	groups	cp_manage_groups	control_panel	173
313	groups	cp_manage_groups_add	cp_manage_group	275
314	groups	cp_manage_groups_modify	cp_manage_group	276
315	groups	cp_manage_groups_prop	cp_manage_group	274
316	groups	cp_manage_groups_remove	cp_manage_group	277
317	groups	group_email	agroup	128
318	groups	group_file	agroup	127
319	groups	group_forum	agroup	125
320	groups	group_virtual_classroom	agroup	126
321	groups	groups	communication	143
322	instructor_gradebook	cp_gradebook	control_panel	167
323	instructor_gradebook	cp_gradebook_chooseItems	cp_gradebook_uploadGrades	259
324	instructor_gradebook	cp_gradebook_chooseStudents	cp_gradebook_uploadGrades	260
325	instructor_gradebook	cp_gradebook_displaySettings	cp_gradebook_gradebookSettings	249
326	instructor_gradebook	cp_gradebook_downloadGrades	cp_gradebook	246
327	instructor_gradebook	cp_gradebook_gradebookSettings	cp_gradebook	245
328	instructor_gradebook	cp_gradebook_item	cp_gradebook	241
329	instructor_gradebook	cp_gradebook_itemDownload	cp_gradebook_item	254
330	instructor_gradebook	cp_gradebook_itemGrades	cp_gradebook_item	253
331	instructor_gradebook	cp_gradebook_itemInfo	cp_gradebook_item	255
332	instructor_gradebook	cp_gradebook_itemReport	cp_gradebook_item	252
333	instructor_gradebook	cp_gradebook_manageCategories	cp_gradebook_gradebookSettings	250
334	instructor_gradebook	cp_gradebook_manageOutcomeDefinition	cp_gradebook	243
335	instructor_gradebook	cp_gradebook_manageScales	cp_gradebook_gradebookSettings	251
336	instructor_gradebook	cp_gradebook_modifyCategory	cp_gradebook_manageCategories	256
337	instructor_gradebook	cp_gradebook_modifyGrade	cp_gradebook	248
338	instructor_gradebook	cp_gradebook_modifyOutcomeDefinition	cp_gradebook	242
339	instructor_gradebook	cp_gradebook_modifyScales	cp_gradebook_manageScales	257
340	instructor_gradebook	cp_gradebook_uploadGradebook	cp_gradebook_uploadGrades	258
341	instructor_gradebook	cp_gradebook_uploadGrades	cp_gradebook	247
342	instructor_gradebook	cp_gradebook_user	cp_gradebook	240
343	instructor_gradebook	cp_gradebook_userDownload	cp_gradebook_user	263
344	instructor_gradebook	cp_gradebook_userGrades	cp_gradebook_user	262
345	instructor_gradebook	cp_gradebook_userInfo	cp_gradebook_user	264
346	instructor_gradebook	cp_gradebook_userReport	cp_gradebook_user	261
347	instructor_gradebook	cp_gradebook_viewGradesByItem	cp_gradebook_views	265
348	instructor_gradebook	cp_gradebook_viewGradesByUser	cp_gradebook_views	266
349	instructor_gradebook	cp_gradebook_views	control_panel	168
350	instructor_gradebook	cp_gradebook_weightGrades	cp_gradebook	244
351	instructor_gradebook	cp_gradebookviews_item	cp_gradebook_viewGradesByItem	268
352	instructor_gradebook	cp_gradebookviews_itemInfo	cp_gradebookviews_item	270
353	instructor_gradebook	cp_gradebookviews_modifyOutcome	cp_gradebook_viewGradesByItem	269
354	instructor_gradebook	cp_gradebookviews_user	cp_gradebook_viewGradesByUser	267
355	manual	student_manual	course_tools_area	211
356	messages	messages	communication	425
357	messages	messages_manager	control_panel	426
358	observer	observer_mgmt	admin_main	98
359	observer	observer_mod	observer_mgmt	342
360	observer	observer_useradd	observer_mod	343
361	observer	observer_userdel	observer_mod	344
362	observer_tools	observer_calendar	observer_tools_link	345
363	observer_tools	observer_tasks	observer_tools_link	347

#	APPLICATION	INTERNAL_HANDLE	FAMILY	PK1
364	observer_tools	observer_tools_link	course_admin_button	194
365	observer_tools	observer_view_grades	observer_tools_link	346
366	personal_info	admin_club_add_users	admin_club_properties	33
367	personal_info	admin_club_list_users	admin_club_properties	31
368	personal_info	admin_club_remove_users	admin_club_properties	32
369	personal_info	admin_course_add_users	admin_course_properties	46
370	personal_info	admin_course_remove_users	admin_course_properties	48
371	personal_info	admin_modify_user_in_club	admin_club_list_users	30
372	personal_info	batch_enroll_org	admin_main	78
373	personal_info	batch_enroll_users	admin_main	79
374	personal_info	delete_user_from_course	list_courses_by_user	316
375	personal_info	list_courses_by_user	list_users	318
376	personal_info	modify_user_role	list_courses_by_user	317
377	personal_info	my_inst_personal_change_password	my_inst_personal_info	338
378	personal_info	my_inst_personal_edit	my_inst_personal_info	337
379	personal_info	my_inst_personal_info	0	25
380	personal_info	my_inst_personal_privacy_options	my_inst_personal_info	341
381	personal_info	my_inst_personal_set_cdrom	my_inst_personal_info	339
382	personal_info	my_inst_personal_textbox_options	my_inst_personal_info	340
383	personal_info	password_modify	list_users	320
384	personal_info	personal_change_password	personal_info	363
385	personal_info	personal_edit	personal_info	362
386	personal_info	personal_info	course_tools_area	208
387	personal_info	personal_privacy_options	personal_info	366
388	personal_info	personal_set_cdrom	personal_info	364
389	personal_info	personal_textbox_options	personal_info	365
390	personal_info	self_account_create	0	17
391	personal_info	user_properties	list_users	319
392	resources	cp_academic_web_button	control_panel	183
393	resources	resources	0	19
394	sen-senwhosonline	sen-senwhosonline-nav-1	admin_main	402
395	services	lf_services	lower_frame	323
396	staff_information	cp_staff_information	control_panel	156
397	staff_information	staff_information	course_button	195
398	student_gradebook	check_grade	course_tools_area	210
399	student_gradebook	my_grades	0	21
400	tasks	cp_tasks	control_panel	157
401	tasks	my_tasks	0	20
402	tasks	tasks	course_tools_area	212

12.5 APPENDIX E: APPLICATIONS OF THE BLACKBOARD VLE

#	APPLICATION	Name	PK1
1	academic_resources	Academic Resources	24
2	address_book	Address Book	2
3	admin	Administrator Panel	25
4	announcements	Announcements	1
5	bb-glossary	Glossary	32
6	calendar	Calendar	29
7	chalkbox	ChalkBox	94
8	chalkcourse	Chalk Title Management	95
9	collaboration	Collaboration	19
10	community	Community Page	22
11	content	Content Area	7
12	course_communications	Communications Area	3
13	course_email	Email	4
14	course_roster	Roster	5
15	course_tools_area	Tools Area	6
16	courses	Courses Page	21
17	discussion_board	Discussion Board	8
18	dropbox	Dropbox	9
19	edit_homepage	Homepage	28
20	electric_blackboard	The Electric Blackboard	10
21	groups	Groups	13
22	instructor_gradebook	Gradebook	11
23	manual	Manual	14
24	messages	Messages	33
25	observer	Observer	26
26	observer_tools	Observer Tools	27
27	personal_info	Personal Information	15
28	resources	Resources	16
29	services	Services Page	23
30	staff_information	Staff Information	17
31	student_gradebook	My Grades	12
32	tasks	Tasks	18

12.6 APPENDIX F: MS SQL DATA COLLECTION QUERIES

Not all the institutes have Oracle databases and use MicroSoft SQL server. To acquire logging data from institutes which uses the MicroSoft SQL server the queries were converted. In this section the same queries as before are presented but in the MSSQL format, which are:

Query SystemRegistry.sql

```
SELECT CAST(LTRIM(RTRIM(registry_key)) AS VARCHAR) + ',' +
CAST(LTRIM(RTRIM(registry_value)) AS VARCHAR)
FROM  bb_bb60.dbo.system_registry ;
```

Query Plugins.sql

```
SELECT CAST(plugins_pk1 AS VARCHAR) + ',' + CAST(LTRIM(RTRIM(application)) AS
VARCHAR) + ',' + CAST(LTRIM(RTRIM(label)) AS VARCHAR) + ',' +
CAST(LTRIM(RTRIM(type)) AS VARCHAR) + ',' + CAST(LTRIM(RTRIM(name)) AS VARCHAR)
FROM  bb_bb60_stats.dbo.application
WHERE  plugins_pk1  is not null ;
```

Query CourseMain.sql

```
SELECT CAST(pk1 AS VARCHAR) + ',' + CAST(classifications_pk1 AS VARCHAR) + ',' +
CAST(CONVERT(DATETIME, CONVERT(VARCHAR(23), dtcreated, 112)) AS VARCHAR) + 'T' +
CAST(CONVERT(VARCHAR(23), dtcreated, 108) AS VARCHAR) + ',' +
CAST(CONVERT(VARCHAR(23), dtcreated) AS VARCHAR) + ' ' + CAST(CONVERT(VARCHAR(23),
dtcreated, 108) AS VARCHAR) + ',' + CAST(CONVERT(DATETIME, CONVERT(VARCHAR(23),
dtmodified, 112)) AS VARCHAR) + 'T' + CAST(CONVERT(VARCHAR(23), dtmodified, 108) AS
VARCHAR) + ',' + CAST(CONVERT(VARCHAR(23), dtmodified) AS VARCHAR) + ' ' +
CAST(CONVERT(VARCHAR(23), dtmodified, 108) AS VARCHAR) + ',' +
CAST(LTRIM(RTRIM(service_level)) AS VARCHAR)
FROM  bb_bb60_stats.dbo.course_main ;
```

Query SystemTracking.sql

```
SELECT CAST(CONVERT(DATETIME, CONVERT(VARCHAR(23), timestamp, 112)) AS VARCHAR) +
'T' + CAST(CONVERT(VARCHAR(23), timestamp, 108) AS VARCHAR) + ',' +
CAST(CONVERT(VARCHAR(23), timestamp) AS VARCHAR) + ' ' + CAST(CONVERT(VARCHAR(23),
timestamp, 108) AS VARCHAR) + ',' + CAST(courses AS VARCHAR) + ',' +
CAST(organizations AS VARCHAR) + ',' + CAST(users AS VARCHAR) + ',' +
CAST(course_users_p AS VARCHAR) + ',' + CAST(course_users_s AS VARCHAR) + ',' +
CAST(page_views AS VARCHAR)
FROM  bb_bb60_stats.dbo.system_tracking ;
```

Query Handle.sql

```
SELECT CAST(aa.COURSE_PK1 AS VARCHAR) + ',' + CAST(aa.USER_PK1 AS VARCHAR) + ',' +
CAST(u.INSTITUTION_ROLES_PK1 AS VARCHAR) + ',' + CAST(aa.SESSION_ID AS VARCHAR) +
',' + CAST(CONVERT(DATETIME, CONVERT(VARCHAR(23), aa.timestamp, 112)) AS VARCHAR) +
'T' + CAST(CONVERT(VARCHAR(23), aa.timestamp, 108) AS VARCHAR) + ',' +
CAST(CONVERT(VARCHAR(23), aa.timestamp) AS VARCHAR) + ' ' +
CAST(CONVERT(VARCHAR(23), aa.timestamp, 108) AS VARCHAR) + ',' +
CAST(aa.INTERNAL_HANDLE AS VARCHAR)
FROM  bb_bb60_stats.dbo.activity_accumulator aa,
        bb_bb60_stats.dbo.users u,
        bb_bb60_stats.dbo.course_main cm
WHERE  aa.USER_pk1  = u.PK1
AND aa.COURSE_PK1  = cm.PK1
AND USER_PK1  is not null
AND COURSE_PK1  is not null
AND USER_PK1  <> 6
AND INTERNAL_HANDLE  in ( 'cp_announcements'  , 'cp_course_calendar'  ,
'cp_staff_information'  , 'cp_gradebook'  , 'cp_academic_web_button'  ,
'staff_information'  , 'check_grade'  , 'student_manual'  , 'ab_add_contact'  ,
'student_roster'  , 'personal_info'  , 'edit_homepage'  , 'cp_collaboration'  ,
```

```
'collaboration'  , 'course_tools_area'  , 'cp_digital_dropbox'  ,
'electric_blackboard'  , 'cp_add_group'  , 'course_communications'  ,
'cp_discussion_board'  , 'db_message'  , 'db_post_message'  ,
'discussion_board_entry'  , 'discussion_board'  , 'cp_send_email'  ,
'messages_manager'  , 'cp_content'  , 'cp_tasks'  )
GROUP BY course_pk1, user_pk1, institution_roles_pk1, session_id, timestamp,
internal_handle   ;
```

Query Duration.sql

```
SELECT CAST(session_id AS VARCHAR) + ',' +
CAST(CAST(ROUND(datediff(hh,MAX(timestamp),MIN(timestamp)),0) AS INTEGER) AS
VARCHAR)
FROM  bb_bb60_stats.dbo.activity_accumulator
WHERE  session_id  > 1
GROUP BY  session_id ;
```

12.7 APPENDIX G: INSTITUTECLASS AND STARTDATE OF THE BLACKBOARD VLES

Owner	Courses & Comm's	Handle & Duration	K12	FE	HE	Co	Install Date	First Timestamp	Last Timestamp	Lifetime VLE
Bb001	125	yes			1		09-28-2004	09-29-2004	05-09-2006	587
Bb002	3357	yes			1		12-05-2002	01-03-2002	05-09-2006	1587
Bb003	2826	no			1		12-24-2002	12-26-2002	05-09-2006	1230
Bb004	208	yes			1		08-29-2005	08-30-2005	05-09-2006	252
Bb005	473	no	1				12-31-2002	12-31-2002	05-09-2006	1225
Bb006	13	yes			1		09-23-2005	09-24-2005	05-09-2006	227
Bb007	8039	no			1		12-27-2002	01-10-2003	10-03-2004	632
Bb008	1131	yes			1		08-11-2003	07-06-2001	05-09-2006	1768
Bb009	18	yes				1	01-10-2003	01-15-2003	05-09-2006	1210
Bb010	27476	yes			1		01-30-2003	03-18-2002	05-09-2006	1513
Bb011	699	yes			1		05-22-2003	09-23-2002	05-09-2006	1324
Bb012	147	yes			1		08-12-2003	06-06-2002	01-07-2004	580
Bb013	4	yes		1			03-18-2005	03-19-2005	05-09-2006	416
Bb014	1798	yes			1		12-12-2002	12-25-2002	05-08-2006	1230
Bb015	312	yes	1				12-16-2002	12-18-2002	05-09-2006	1238
Bb016	32307	yes	1				05-22-2003	05-23-2003	04-04-2006	1047
Bb017	9341	yes			1		01-08-2003	01-10-2003	05-09-2006	1215
Bb018	2964	yes			1		12-27-2004	06-10-2002	05-09-2006	1429
Bb019	14376	no			1		05-05-2003	12-12-2000	01-14-2004	1128
Bb020	2569	yes			1		12-13-2004	01-07-2003	05-09-2006	1218
Bb021	828	yes			1		11-30-2004	12-01-2004	05-09-2006	524
Bb022	616	yes			1		12-26-2002	12-28-2002	05-09-2006	1228
Bb023	881	yes			1		12-19-2002	12-22-2002	05-09-2006	1234
Bb024	1479	yes			1		06-20-2003	10-06-2000	05-08-2006	2040
Bb025	288	yes			1		12-26-2002	12-28-2002	05-09-2006	1228
Bb026	22155	no			1		04-21-2003	04-22-2003	05-09-2006	1113
Bb027	1060	yes			1		01-03-2003	01-07-2003	05-09-2006	1218
Bb028	1244	yes			1		12-04-2002	12-19-2002	12-21-2005	1098
Bb029	26723	no			1		12-11-2002	01-01-2003	05-09-2006	1224
Bb030	933	yes			1		05-22-2003	08-21-2000	05-09-2006	2087
Bb031	6	yes			1		02-17-2006	02-18-2006	05-09-2006	80
Bb032	11148	no			1		11-20-2002	01-16-2003	05-09-2006	1209
Bb033	3405	yes			1		12-24-2002	12-26-2002	05-09-2006	1230
Bb034	372	yes			1		12-06-2002	12-07-2002	05-09-2006	1249
Bb035	2249	yes				1	07-22-2003	06-11-2002	01-27-2005	961
Bb036	3986	no			1		01-16-2003	01-20-2000	12-23-2003	1433
Bb037	428	yes			1		01-02-2003	01-04-2003	05-09-2006	1221
Bb038	2178	yes			1		01-14-2005	09-04-2001	05-09-2006	1708
Bb039	47752	no			1		05-24-2004	10-09-2001	05-08-2006	1672
Bb040	173	yes			1		03-19-2003	03-20-2003	05-09-2006	1146
Bb041	637	yes	1				10-01-2002	10-01-2002	05-09-2006	1316
Bb042	1455	yes			1		01-03-2003	01-07-2003	05-09-2006	1218
Bb043	51	yes			1		02-10-2006	02-11-2006	05-09-2006	87
Bb044	548	yes			1		12-10-2002	12-20-2002	05-09-2006	1236
Bb045	2306	yes			1		01-06-2003	01-08-2003	05-09-2006	1217
Bb046	892	yes			1		04-18-2003	04-19-2003	04-22-2005	734
Bb047	2500	yes			1		11-21-2002	12-20-2002	05-09-2006	1236
Bb048	2265	no			1		12-31-2002	01-01-2003	03-18-2004	442
Bb049	416	yes				1	12-04-2002	12-10-2002	05-09-2006	1246
Bb050	14	yes			1		12-22-2005	12-23-2005	05-09-2006	137
Bb051	107638	no			1		03-26-2004	12-21-1999	05-09-2006	2331
Bb052	1568	yes			1		12-26-2002	12-28-2002	05-09-2006	1228
Bb053	2112	no		1			12-16-2004	12-17-2004	05-09-2006	508
Bb054	1814	yes			1		01-24-2003	01-25-2003	05-09-2006	1200
Bb055	1158	yes			1		12-12-2002	12-24-2002	05-09-2006	1232
Bb056	36	no		1			10-31-2002	11-07-2002	11-18-2004	742
Bb057	208	yes		1			12-16-2002	12-20-2002	05-09-2006	1236
Bb058	9655	no				1	08-05-2005	07-28-2000	05-09-2006	2111
Bb059	3975	yes			1		05-08-2003	12-22-2000	05-08-2006	1963
Bb060	3396	yes	1				12-05-2002	12-07-2002	05-09-2006	1249
Bb061	49380	no			1		12-19-2002	12-25-2002	04-26-2006	1218
Bb062	1648	no			1		08-16-2004	07-03-2001	05-09-2006	1771
Bb063	13113	no			1		01-08-2003	01-14-2003	12-19-2005	1070
Bb064	356	yes			1		08-29-2005	11-08-2001	05-09-2006	1643
Bb065	326	yes			1		09-24-2003	09-25-2003	05-09-2006	957
Bb066	1664	yes			1		12-19-2002	12-24-2002	05-09-2006	1232

Owner	Courses & Comm's	Handle & Duration	K12	FE	HE	Co	Install Date	First Timestamp	Last Timestamp	Lifetime VLE
Bb067	2009	yes			1		10-09-2003	06-27-2001	05-08-2006	1776
Bb068	3983	yes			1		12-23-2002	12-31-2002	03-14-2006	1169
Bb069	260	yes			1		12-16-2004	12-18-2004	05-09-2006	507
Bb070	8534	yes			1		12-20-2002	12-24-2002	05-09-2006	1232
Bb071	273	yes			1		12-16-2002	12-20-2002	05-08-2006	1235
Bb072	236	yes			1		11-22-2004	07-03-2001	05-09-2006	1771
Bb073	863	yes			1		12-27-2002	12-31-2002	05-09-2006	1225
Bb074	68921	no			1		12-26-2002	12-27-2002	05-01-2005	856
Bb075	205	yes			1		05-24-2004	05-25-2004	05-09-2006	714
Bb076	25	yes			1		12-12-2002	12-18-2002	05-09-2006	1238
Bb077	4436	no			1		12-29-2003	10-23-2000	08-30-2004	1407
Bb078	47	yes			1		08-27-2004	08-28-2004	05-09-2006	619
Bb079	7438	no			1		04-10-2005	08-02-2000	05-09-2006	2106
Bb080	540	yes	1				05-09-2003	05-01-2003	05-09-2006	1104
Bb081	28394	no			1		04-13-2004	01-04-2000	05-08-2006	2316
Bb082	4900	no			1		11-25-2002	08-26-2000	02-25-2005	1644
Bb083	141	yes			1		01-03-2003	01-07-2003	02-16-2005	771
Bb084	3539	no			1		03-18-2003	05-17-2001	05-09-2006	1818
Bb085	1417	yes			1		03-02-2003	03-03-2003	05-09-2006	1163
Bb086	269	yes			1		07-30-2003	11-29-2001	05-09-2006	1622
Bb087	19643	yes	1				06-10-2003	06-10-2003	05-09-2006	1064
Bb088	5874	no			1		12-08-2003	12-04-2001	05-09-2006	1617
Bb089	386	yes	1				06-23-2003	08-15-2001	05-09-2006	1728
Bb090	5940	no			1		06-24-2003	04-04-2001	08-20-2005	1599
Bb091	902	yes			1		06-25-2003	06-26-2003	05-09-2006	1048
Bb092	1784	no			1		12-04-2002	01-23-2003	05-09-2006	1202
Bb093	55	yes		1			07-17-2003	07-18-2003	05-09-2006	1026
Bb094	2871	yes			1		07-03-2003	07-05-2003	11-05-2004	489
Bb095	3027	yes			1		07-03-2003	07-04-2003	05-09-2006	1040
Bb096	548	yes			1		09-30-2004	09-30-2004	05-09-2006	586
Bb097	1127	yes			1		07-08-2003	07-10-2003	05-08-2006	1033
Bb098	91	yes	1				07-16-2003	07-18-2003	05-09-2006	1026
Bb099	624	yes	1				07-21-2003	07-22-2003	05-09-2006	1022
Bb100	855	yes	1				07-22-2003	08-05-2000	05-09-2006	2103
Bb101	1512	yes			1		07-30-2003	07-30-2001	05-09-2006	1744
Bb102	1912	yes			1		08-13-2003	07-12-2000	05-07-2006	2125
Bb103	9602	yes			1		08-01-2003	08-14-2003	05-05-2006	995
Bb104	248	no		1			07-31-2003	08-01-2003	05-09-2006	1012
Bb105	4382	no			1		08-04-2003	04-03-2001	05-09-2006	1862
Bb106	270	yes			1		08-04-2003	08-05-2003	03-10-2006	948
Bb107	2335	no			1		08-06-2003	12-21-1999	05-08-2006	2330
Bb108	1460	yes	1				08-05-2003	06-11-2002	05-09-2006	1428
Bb109	1708	no			1		08-06-2003	02-19-2001	03-13-2006	1848
Bb110	8326	no			1		08-06-2003	10-19-2000	05-09-2006	2028
Bb111	6191	no			1		08-21-2003	08-23-2003	05-08-2006	989
Bb112	760	no			1		08-22-2003	04-27-2000	11-28-2003	1310
Bb113	17294	no			1		09-11-2003	09-12-2003	05-09-2006	970
Bb114	310	yes	1				10-01-2003	10-02-2003	04-03-2006	914
Bb115	374	yes	1				10-01-2003	10-02-2003	05-09-2006	950
Bb116	309	yes			1		10-07-2003	10-08-2003	05-09-2006	944
Bb117	179	yes			1		10-08-2003	10-09-2003	05-09-2006	943
Bb118	978	no	1				10-09-2003	10-09-2003	01-31-2005	480
Bb119	38	yes			1		08-31-2005	09-01-2005	05-09-2006	250
Bb120	148	yes			1		06-01-2004	11-01-2001	05-09-2006	1650
Bb121	11099	yes			1		01-07-2004	02-25-2000	05-09-2006	2265
Bb122	227	yes			1		01-28-2005	01-29-2005	07-28-2005	180
Bb123	3019	yes			1		06-30-2001	12-03-2003	05-09-2006	888
Bb124	441	yes	1				12-05-2003	06-19-2000	05-09-2006	2150
Bb125	1621	yes			1		09-20-2004	01-09-2001	05-09-2006	1946
Bb126	2025	yes		1			12-11-2003	07-18-2000	05-09-2006	2121
Bb127	1639	yes			1		12-16-2004	12-07-1999	05-09-2006	2345
Bb128	2336	no			1		12-15-2003	08-24-2000	05-09-2006	2084
Bb129	859	no			1		12-17-2003	09-26-2001	08-10-2005	1414
Bb130	8361	yes			1		12-23-2003	05-04-2001	05-09-2006	1831
Bb131	635	yes			1		12-23-2003	05-25-2000	05-09-2006	2175
Bb132	2362	no			1		12-31-2003	05-24-2000	02-27-2006	2105
Bb133	723	yes			1		01-05-2004	02-25-2000	05-09-2006	2265
Bb134	1266	no			1		01-09-2004	01-10-2004	05-09-2006	850
Bb135	598	yes			1		02-18-2004	03-23-2000	05-09-2006	2238
Bb136	2077	no			1		03-09-2004	05-17-2001	11-12-2004	1275
Bb137	296	yes			1		06-02-2004	06-03-2004	11-17-2005	532
Bb138	damaged	age								
Bb139	3464	no			1		04-02-2003	04-03-2003	05-09-2006	1132

Owner	Courses & Comm's	Handle & Duration	K12	FE	HE	Co	Install Date	First Timestamp	Last Timestamp	Lifetime VLE
Bb140	1285	yes			1		04-02-2004	08-24-2001	05-09-2006	1719
Bb141	38836	no			1		12-06-2004	12-19-2000	05-09-2006	1967
Bb142	16202	yes			1		04-21-2004	03-07-2001	05-09-2006	1889
Bb143	2650	no			1		04-26-2004	02-21-2000	05-09-2006	2269
Bb144	128	yes			1		04-27-2004	09-26-2001	05-09-2006	1686
Bb145	1508	yes			1		04-28-2004	09-07-2000	05-09-2006	2070
Bb146	946	yes			1		05-06-2004	08-07-2001	10-19-2004	1169
Bb147	500	yes			1		05-10-2004	10-05-2000	05-09-2006	2042
Bb148	2263	no			1		05-18-2004	05-19-2004	07-26-2005	433
Bb149	936	yes			1		05-19-2004	06-06-2002	05-08-2006	1432
Bb150	1135	no	1				07-23-2004	08-30-2001	05-08-2006	1712
Bb151	24104	no			1		06-15-2004	01-10-2001	05-09-2006	1945
Bb152	140	yes	1				06-08-2004	06-09-2004	05-09-2006	699
Bb153	9102	no			1		06-14-2004	06-15-2004	05-09-2006	693
Bb154	566	yes	1				06-28-2004	04-02-2002	05-09-2006	1498
Bb155	53789	no			1		06-28-2004	02-04-2000	10-28-2005	2093
Bb156	1906	yes			1		06-29-2004	08-10-2001	05-09-2006	1733
Bb157	794	yes			1		07-25-2004	01-17-2001	05-09-2006	1938
Bb158	178	yes			1		06-30-2004	07-01-2004	05-09-2006	677
Bb159	6609	no	1				07-09-2003	07-10-2003	05-09-2006	1034
Bb160	323	yes			1		07-01-2004	07-02-2004	05-09-2006	676
Bb161	63	yes			1		08-25-2004	08-26-2004	08-26-2004	0
Bb162	617	yes			1		07-08-2004	09-03-2003	05-09-2006	979
Bb163	5406	yes			1		07-14-2004	11-08-2000	05-09-2006	2008
Bb164	10587	no			1		07-15-2004	01-05-2001	07-23-2004	1295
Bb165	2794	yes			1		07-26-2004	12-20-2001	05-09-2006	1601
Bb166	1067	yes			1		08-05-2004	07-13-2001	05-09-2006	1761
Bb167	43	yes			1		08-06-2004	08-07-2004	05-09-2006	640
Bb168	379	yes			1		08-10-2004	01-14-2001	05-09-2006	1941
Bb169	8846	no			1		08-12-2004	08-11-2000	07-22-2005	1806
Bb170	484	yes			1		08-16-2004	05-08-2000	05-09-2006	2192
Bb171	191	yes			1		08-19-2004	12-26-2001	05-09-2006	1595
Bb172	2685	no			1		08-25-2004	12-21-1999	08-02-2005	2051
Bb173	47	yes	1				08-31-2004	09-01-2004	05-09-2006	615
Bb174	3213	yes			1		10-11-2004	10-12-2004	05-09-2006	574
Bb175	damaged	age								
Bb176	33	yes			1		05-13-2005	05-14-2005	05-09-2006	360
Bb177	827	yes	1				11-02-2004	11-03-2004	05-09-2006	552
Bb178	2850	yes			1		06-23-2003	08-14-2003	05-08-2006	998
Bb179	1416	yes			1		05-19-2005	09-18-2000	05-09-2006	2059
Bb180	224	yes			1		11-16-2004	11-17-2004	05-09-2006	538
Bb181	1	yes				1	12-06-2004	12-07-2004	05-09-2006	518
Bb182	7917	no			1		12-21-2004	02-09-2000	05-09-2006	2281
Bb183	2734	yes			1		12-27-2004	04-04-2002	05-09-2006	1496
Bb184	1556	yes			1		12-30-2004	06-04-2001	05-09-2006	1800
Bb185	455	yes			1		01-06-2005	01-07-2005	05-09-2006	487
Bb186	1249	yes			1		08-25-2004	05-05-2000	05-09-2006	2195
Bb187	514	yes			1		01-10-2005	01-12-2005	05-09-2006	482
Bb188	8858	no			1		01-11-2005	01-12-2005	05-09-2006	482
Bb189	59	yes				1	05-10-2005	10-07-2002	05-09-2006	1310
Bb190	1	yes			1		04-13-2005	04-14-2005	05-09-2006	390
Bb191	101	yes				1	11-03-2003	11-04-2003	05-09-2006	917
Bb192	86	yes			1		06-13-2005	03-13-2001	05-08-2006	1882
Bb193	95	yes			1		07-06-2005	07-07-2005	05-09-2006	306
Bb194	3217	no			1		07-15-2005	07-16-2005	05-09-2006	297
Bb195	23	yes		1			08-08-2005	09-28-2001	05-09-2006	1684
Bb196	22	yes			1		09-01-2005	09-02-2005	05-09-2006	249
Bb197	9425	no			1		09-02-2005	09-03-2005	05-08-2006	247
Bb198	542	yes		1			09-23-2005	01-31-2002	05-09-2006	1559
Bb199	40	yes			1		11-21-2005	06-11-2002	05-09-2006	1428
Bb200	damaged	age								
Bb201	1	yes	1				01-09-2006	01-10-2006	05-09-2006	119
Bb202	16	yes			1		01-23-2006	01-24-2006	05-09-2006	105
Bb203	18	yes			1		03-01-2006	03-02-2006	05-09-2006	68
Bb204	47	yes			1		03-15-2006	03-16-2006	05-09-2006	54
Bb205	103	yes	1				07-21-2003	07-22-2003	05-09-2006	1022
Bb206	12911	no			1		01-23-2005	01-25-2005	05-09-2006	469
Bb207	11577	yes			1		03-16-2005	03-18-2005	05-07-2006	415
Bb208	377	yes		1			09-09-2005	09-10-2005	05-08-2006	240
Bb209	3332	yes			1		12-09-2004	05-03-2002	05-09-2006	1467
Bb210	7	yes			1		11-21-2005	11-22-2005	05-09-2006	168
Bb211	16	yes			1		09-09-2005	09-10-2005	05-09-2006	241
Bb212	190	yes		1			03-23-2005	03-24-2005	05-09-2006	411

Owner	Courses & Comm's	Handle & Duration	K12	FE	HE	Co	Install Date	First Timestamp	Last Timestamp	Lifetime VLE
Bb213	12069	no				1	01-27-2003	01-28-2003	05-09-2006	1197
Bb214	33	yes			1		03-30-2005	03-31-2005	04-26-2005	26
Bb215	29	yes				1	08-25-2005	08-26-2005	05-09-2006	256
Bb216	1320	yes			1		12-27-2002	12-31-2002	05-09-2006	1225
Bb217	830	yes			1		04-12-2005	04-13-2005	05-09-2006	391
Bb218	59	yes		1			04-12-2005	04-13-2005	05-09-2006	391
Bb219	2895	no			1		04-13-2005	04-14-2005	05-09-2006	390
Bb220	2669	yes			1		04-14-2005	04-15-2005	05-09-2006	389
Bb221	4702	no			1		04-18-2005	04-19-2005	05-09-2006	385
Bb222	4075	yes			1		04-19-2005	04-20-2005	05-09-2006	384
Bb223	42	yes			1		09-15-2005	09-16-2005	04-26-2006	222
Bb224	45	yes			1		04-22-2005	04-23-2005	05-09-2006	381
Bb225	49	yes			1		04-27-2005	04-28-2005	05-09-2006	376
Bb226	36	yes			1		05-17-2005	05-18-2005	05-08-2006	355
Bb227	20191	no			1		05-20-2005	05-21-2005	05-08-2006	352
Bb228	156	yes			1		05-19-2005	05-20-2005	05-09-2006	354
Bb229	12	yes			1		05-20-2005	05-20-2005	05-08-2006	353
Bb230	10	yes			1		05-23-2005	05-24-2005	05-09-2006	350
Bb231	216	yes			1		06-08-2005	06-09-2005	05-09-2006	334
Bb232	256	yes			1		09-12-2003	09-16-2003	05-09-2006	966
Bb233	720	yes			1		07-26-2005	08-02-2005	05-09-2006	280
Bb234	701	yes			1		06-24-2005	06-25-2005	05-08-2006	317
Bb235	2	yes			1		07-07-2005	07-08-2005	05-08-2006	304
Bb236	1596	yes			1		07-07-2005	07-07-2005	05-09-2006	306
Bb237	2	yes			1		07-13-2005	07-14-2005	05-08-2006	298
Bb238	2839	yes			1		07-14-2005	07-14-2005	05-08-2006	298
Bb239	1	yes			1		07-13-2005	07-14-2005	05-08-2006	298
Bb240	3832	yes			1		07-14-2005	07-14-2005	05-08-2006	298
Bb241	2	yes			1		07-14-2005	07-15-2005	05-08-2006	297
Bb242	40	yes			1		07-27-2005	07-28-2005	05-09-2006	285
Bb243	1603	yes			1		08-02-2005	08-02-2005	05-09-2006	280
Bb244	203	yes			1		08-05-2005	08-06-2005	05-09-2006	276
Bb245	1517	yes			1		08-29-2005	08-29-2005	05-09-2006	253
Bb246	5	yes			1		08-29-2005	08-30-2005	05-09-2006	252
Bb247	76	yes			1		09-21-2005	09-22-2005	05-09-2006	229
Bb248	409	yes			1		09-22-2005	09-23-2005	05-09-2006	228
Bb249	79	yes			1		09-27-2005	09-28-2005	05-09-2006	223
Bb250	24	yes			1		09-28-2005	09-29-2005	05-09-2006	222
Bb251	2	yes			1		09-29-2005	09-30-2005	05-09-2006	221
Bb252	21406	yes			1		10-31-2003	09-28-2001	05-09-2006	1684
Bb253	72	yes			1		10-06-2005	10-07-2005	05-09-2006	214
Bb254	4	yes			1		10-07-2005	10-12-2005	11-17-2005	36
Bb255	3	yes			1		10-10-2005	10-11-2005	05-09-2006	210
Bb256	181	yes			1		09-15-2005	09-16-2005	05-09-2006	235
Bb257	235	yes			1		10-28-2005	10-29-2005	05-09-2006	192
Bb258	783	yes		1			10-30-2005	10-31-2005	03-10-2006	130
Bb259	9328	no			1		12-14-2002	12-15-2002	05-09-2006	1241
Bb260	1195	yes			1		12-15-2005	12-24-2005	05-09-2006	136
Bb261	37	yes		1			12-16-2005	12-17-2005	05-09-2006	143
Bb262	2191	yes			1		12-28-2005	12-29-2005	05-09-2006	131
Bb263	3169	yes			1		01-13-2006	01-14-2006	05-09-2006	115
Bb264	damaged	age								
Bb265	8	yes			1		03-08-2006	03-09-2006	05-09-2006	61
Bb266	82	yes			1		03-21-2006	03-22-2006	05-09-2006	48
Bb267	1	yes			1		03-24-2006	03-25-2006	05-09-2006	45
Bb268	22131	no			1		04-21-2003	04-22-2003	05-04-2006	1108
Bb269	4792	yes			1		01-03-2003	01-04-2003	05-09-2006	1221
Bb270	392	yes			1		03-30-2006	03-31-2006	05-09-2006	39
Bb271	43	yes			1		04-04-2006	04-04-2006	05-08-2006	34
Bb272	3	yes				1	04-04-2006	04-04-2006	05-08-2006	34
Bb273	1	yes			1		04-12-2006	04-13-2006	05-09-2006	26
Bb274	2	yes	1				04-14-2006	04-15-2006	05-08-2006	23
Bb275	1582	yes	1				07-20-2005	08-13-2005	05-09-2006	269
Bb276	24	yes				1	04-13-2006	04-14-2006	05-09-2006	25
Bb277	149	yes				1	04-18-2006	04-19-2006	05-09-2006	20
Bb278	3	yes	1				04-24-2006	04-25-2006	05-09-2006	14
Bb279	1	yes			1		04-24-2006	04-25-2006	05-09-2006	14
Bb280	49484	no			1		12-19-2002	12-25-2002	05-02-2006	1224
Bb281	28337	no			1		04-13-2004	01-04-2000	05-08-2006	2316
Bb282	2	yes			1		04-25-2006	04-26-2006	05-10-2006	14
Bb283	5858	no			1		03-29-2004	03-30-2004	05-09-2006	770
Bb284	1	yes			1		05-05-2006	05-05-2006	05-08-2006	3
Bb285	3249	yes			1		07-16-2004	04-26-2000	09-18-2004	1606

Owner	Courses & Comm's	Handle & Duration	K12	FE	HE	Co	Install Date	First Timestamp	Last Timestamp	Lifetime VLE
Bb286	4227	yes			1		07-06-2004	09-03-2002	07-07-2005	1038
Bb287	7395	yes			1		03-05-2003	07-04-2002	04-09-2006	1375
Bb288	6159	yes			1		02-12-2004	02-26-2004	06-12-2006	837
Bb289	2384	yes			1		07-12-2004	10-03-2001	03-22-2006	1631
Bb290	5073	yes			1		03-31-2003	04-04-2000	04-03-2006	2190
Bb291	27315	yes			1		07-17-2003	07-16-2003	08-25-2004	406
Bb292	7661	yes			1		06-24-2003	07-01-2003	07-25-2005	755
Bb293	2935	yes			1		02-04-2003	02-08-2003	03-15-2006	1131

K12 – primary and secondary education
PE – further education
HE – higher education
Co - corporate

12.8 APPENDIX H: COURSECLASS OR PROFESSIONS OF BLACKBOARD

CourseClass	Profession
1	Architecture
2	Art_History
3	Art_Appreciation
4	Computer_Graphics
5	Modern_Art
6	Photography
7	StudioArt
8	Studio_Art_Painting
9	Studio_Art_Sculpture
10	Studio_Art_Drawing
11	Music
12	Music_History
13	Music_Theory
14	Music_Performance
15	Dance
16	Theatre
17	Drama
20	Arabic
18	Not_Applicable
19	Languages
21	Chinese
22	English
23	French
24	German
25	Italian
26	Japanese
27	Portugese
28	Russian
29	Sign_Language
30	Spanish
31	Other
32	Not_Applicable
33	Not_Applicable
34	Literature_Linguistics
35	Classics
36	Composition
37	Debate
38	English_Literature
39	English_as_Second_Language
40	Folklore_and_Mythology
41	Grammar
42	Journalism
43	Language_Arts
44	Linguistics
45	Literature
46	Reading
47	Speech
48	Writing
49	Business_and_Management
50	Accounting
51	Banking
52	Business_Communications
53	Business_Law
54	Customer_Service
55	Economics
56	Entrepreneurial_Studies
57	Finance
58	General_Management
59	Human_Resources
60	Operations_Management
61	Insurance

CourseClass	Profession
62	International_Trade
63	Investment
64	Leadership
65	Management_and_Organization
66	Marketing_and_Sales
67	Project_Management
68	Quality_Management
69	Real_Estate
70	Retail
71	Retirement_Planning
72	Risk_Management
73	Small_Business
74	Stress_Management
75	Taxes
76	Time_Management
77	Workplace_Safety
78	Not_Applicable
79	Computer_Engineering
80	Agricultural_Studies
81	Architecture_and_Urban_Planning
82	Civil_Engineering
83	Environmental_Engineering
84	Computer_Engineering
85	Computer_Science
86	Electrical_Engineering
87	Mechanical_Engineering
88	Chemical_Engineering
89	Aerospace_Engineering
90	Nuclear_Engineering
91	Industrial_and_Systems_Engineering
92	Not_Applicable
93	Computer_and_Information_Technology
94	Networking
95	Hardware
96	Desktop_Applications
97	Desktop_Publishing
98	Information_Systems_Management
99	Maintenance
100	Multimedia
101	Programming_Languages
102	System_Administration
103	Technical_Support
104	Technical_Writing
105	Internet
106	Not_Applicable
107	Education
108	Administration_and_Planning_and_Social_Policy
109	Distance_Learning
110	Education_Policy_and_Leadership
111	Education_Technology
112	Elementary_and_Secondary_Education
113	Higher_Education
114	Learning_and_Teaching
115	Online_Teaching_and_Learning
116	Teacher_Training
117	Learning_Technology
118	Not_Applicable
119	Legal
120	Administrative_Law
121	Antitrust_Law
122	Business_Law
123	Civil_Procedure
124	Commercial_Law
125	Constitutional_Law
126	Contracts
127	Corporate_Law

CourseClass	Profession
128	Criminal_Law
129	Employment_Law
130	Family_Law
131	Federal_Law
132	Immigration_Law
133	International_Law
134	Law_and_Education
135	Legal_Theory
136	Property_Law
137	Tax_Law
138	Torts
139	Not_Applicable
140	Not_Applicable
141	Medicine_and_Health
142	Biological_Chemistry
143	Dentistry
144	Diseases
145	Drugs
146	Fitness
147	Genetics
148	Medicine
149	Neurobiology
150	Orthodontics
151	Orthodontics
152	Physical_Education
153	Nutrition
154	Not_Applicable
155	Science
156	Anatomy
157	Anthropology
158	Astronomy
159	Biology
160	Cell_Biology
161	Chemistry
162	Earth_Sciences
163	Mathematics
164	Microbiology
165	Physical_Sciences
166	Physics
167	Botany
168	Not_Applicable
169	Ecology
170	Geology
171	Horticulture
172	LifeScience
173	Meteorology
174	Physiolog
175	Wildlife
176	Zoology
177	Not_Applicable
178	Not_Applicable
179	Mathematics
180	Algebra
181	Arithmetic
182	Calculus
183	Geometry
184	Discrete_Math
185	Math_Analysis
186	Trigonometry
187	Probability_and_Statistics
188	Not_Applicable
189	Not_Applicable
190	Social_Sciences_or_Social_Study
191	Civics
192	Classical_Civilization_Studies
193	Housing_and_Urban_Development_and_Planning

CourseClass	Profession
194	Communications
195	Current_Events
196	Economics
197	Future_Problem_Solving
198	Geography
199	Government
200	History
201	Human_Development
202	Humanities
203	International_and_Public_Affairs
204	Philosophy
205	Political_Science
206	Psychology
207	Public_Health
208	Religion
209	Social_Work
210	Sociology
211	World_Civilizations
212	World_History
213	African_American_Studies
214	American_Studies
215	Ethnic_Cultures
216	Gender_Studies
217	Judaic_Studies
218	Military
219	Multi_interdisciplinary_studies
220	Society_and_Culture
221	Not_Applicable
222	Vocational
223	Library_Sciences
224	Lifestyle
225	Office_and_Secretaria
226	Outdoors
227	Personal_and_Miscellaneous_Services
228	Careers
229	Health_and_Fitness
230	Real_Estate
231	Automotive
232	Audio_Video
233	Child_Development
234	Computer_Technology
235	Cooking
236	Electronics
237	Guidance
238	Home_Economics
239	ROTC
240	Shop
241	Travel
242	Not_Applicable
243	Physical_Education
244	Fitness
245	Health
246	Sex_Education
247	Sports
248	Not_Applicable
249	Hobbies
250	Astrology
251	Amateur_Radio
252	Magazines
253	Radio_Scouting
254	Software
255	Arts_and_Crafts
256	Astronomy
257	Collecting
258	Antiques
259	Coins

CourseClass	Profession
260	Comic_Books
261	Stamps
262	Toys
263	Games
264	Garden
265	Home_and_Gardening
266	Models
267	Outdoors
268	Writing

12.9 Appendix I: Professions to ScienceClass of Blackboard

Professions per ScienceClass	Total Courses	ID of CourseClass	Number of Institutes with the Course in the Curriculum				
			Gen.	Human.	Natural	Engineer.	Social
Accounting	2076	50					85
Administration_&_Planning_&_ Social_Policy	304	108					88
Administrative_Law	248	120					86
Aerospace_Engineering	170	89				55	
African_American_Studies	74	213		18			
Agricultural_Studies	25	80			48		
Algebra	1142	180			31		
Amateur_Radio	3	251	1				
American_Studies	114	214	2				
Anatomy	302	156			44		
Anthropology	125	157					73
Antiques	1	258	1				
Antitrust_Law	2	121					86
Arabic	45	20		18			
Architecture	88	1				56	
Architecture_&_Urban_Planning	52	81				56	
Arithmetic	29	181			31		
Art_Appreciation	279	3		20			
Art_History	233	2		15			
Arts_&_Crafts	3	255		20			
Astrology	1	250	1				
Astronomy	244	158 and 256			39		
Audio_Video	20	232				53	
Automotive	100	231				55	
Banking	19	51					85
Biological_Chemistry	138	142			42		
Biology	1967	159			42		
Botany	37	167			48		
Business_&_Management	6682	49					85
Business_Communications	604	52	5				
Business_Law	510	53 and 122					86
Calculus	399	182			31		
Careers	118	228	1				
Cell_Biology	39	160			42		
Chemical_Engineering	33	88				58	
Chemistry	1199	161			35		
Child_Development	33	233					79
Chinese	4	21		18			
Civics	59	191				56	
Civil_Engineering	401	82				56	
Civil_Procedure	36	123					74
Classical_Civilization_Studies	8	192		15			
Classics	56	35		15			
Coins	1	259	1				
Comic_Books	8	260	1				
Commercial_Law	40	124					86
Communications	623	194	5				
Composition	1339	36		24			
Computer_&_Information_Technology	5511	93				53	
Computer_Engineering	1863	79 and 84				54	
Computer_Graphics	132	4				54	
Computer_Science	487	85				54	
Computer_Technology	59	234				54	
Constitutional_Law	77	125					86
Contracts	41	126					86
Cooking	40	235					76
Corporate_Law	17	127					86
Criminal_Law	254	128					86
Current_Events	18	195					76
Customer_Service	87	54					76
Dance	95	15					76
Debate	3	37	5				
Dentistry	105	143			44		
Desktop_Applications	1419	96				54	
Desktop_Publishing	68	97	5				

Professions per ScienceClass	*Total Courses*	*ID of CourseClass*	*Number of Institutes with the Course in the Curriculum*				
			Gen.	*Human.*	*Natural*	*Engineer.*	*Social*
Discrete_Math	*46*	*184*			*31*		
Diseases	*191*	*144*			*44*		
Distance_Learning	*1646*	*109*					*81*
Drama	*43*	*17*		*24*			
Drugs	*41*	*145*			*44*		
Earth_Sciences	*498*	*162*				*57*	
Ecology	*123*	*169*			*42*		
Economics	*1707*	*55 and 196*					*83*
Education	*15926*	*107*					*81*
Education_Policy_&_Leadership	*227*	*110*					*81*
Education_Technology	*1237*	*111*					*81*
Electrical_Engineering	*493*	*86*				*53*	
Electronics	*32*	*236*				*53*	
Elementary_&_Secondary_Education	*1807*	*112*					*80*
Employment_Law	*32*	*129*					*85*
English	*725*	*22*		*18*			
English_as_Second_Language	*102*	*39*		*18*			
English_Literature	*604*	*38*		*17*			
Entrepreneurial_Studies	*169*	*56*					*85*
Environmental_Engineering	*12*	*83*			*43*		
Ethnic_Cultures	*126*	*215*					*74*
Family_Law	*21*	*130*					*86*
Federal_Law	*13*	*131*					*86*
Finance	*770*	*57*					*83*
Fitness	*278*	*146 and 244*					*76*
Folklore_&_Mythology	*23*	*40*		*15*			
French	*229*	*23*		*18*			
Future_Problem_Solving	*41*	*197*					*74*
Games	*4*	*263*					*76*
Garden	*5*	*264*			*48*		
Gender_Studies	*75*	*216*					*79*
General_Management	*670*	*58*					*85*
Genetics	*14*	*147*			*42*		
Geography	*301*	*198*					*74*
Geology	*298*	*170*			*38*		
Geometry	*133*	*183*				*56*	
German	*101*	*24*		*18*			
Government	*452*	*199*					*88*
Grammar	*65*	*41*		*17*			
Guidance	*42*	*237*					*80*
Hardware	*51*	*95*				*53*	
Health	*210*	*245*			*44*		
Health_&_Fitness	*43*	*229*			*44*		
Higher_Education	*1161188*	*113*					*81*
History	*1325*	*200*		*15*			
Hobbies	*168*	*249*					*76*
Home_&_Gardening	*8*	*265*					*76*
Home_Economics	*50*	*238*					*83*
Horticulture	*11*	*171*			*48*		
Housing_&_Urban_ Development_&_Planning	*13*	*193*					*74*
Human_Development	*215*	*201*					*80*
Human_Resources	*498*	*59*					*85*
Humanities	*352*	*202*		*30*			
Immigration_Law	*7*	*132*					*86*
Industrial_&_Systems_Engineering	*143*	*91*				*58*	
Information_Systems_Management	*948*	*98*				*54*	
Insurance	*205*	*61*					*83*
International_&_Public_Affairs	*58*	*203*					*88*
International_Law	*54*	*133*					*86*
International_Trade	*148*	*62*					*83*
Internet	*496*	*105*				*54*	
Investment	*45*	*63*					*83*
Italian	*67*	*25*		*18*			
Japanese	*60*	*26*		*18*			
Journalism	*91*	*42*	*5*				
Judaic_Studies	*6*	*217*	*11*				
Language_Arts	*466*	*43*		*17*			
Languages	*483*	*19*		*17*			
Law_&_Education	*131*	*134*					*81*
Leadership	*604*	*64*					*85*
Learning_&_Teaching	*596*	*114*					*81*
Learning_Technology	*261*	*117*					*81*

Professions per ScienceClass	Total Courses	ID of CourseClass	Number of Institutes with the Course in the Curriculum				
			Gen.	Human.	Natural	Engineer.	Social
Legal	2391	119					86
Legal_Theory	35	135					86
Library_Sciences	52	223	6				
LifeScience	224	172			44		
Lifestyle	13	224					76
Linguistics	129	44		18			
Literature	622	45		17			
Literature_Linguistics	1748	34		17			
Magazines	2	252		17			
Maintenance	47	99			49		
Management_&_Organization	1014	65					85
Marketing_&_Sales	1259	66					83
Math_Analysis	134	185			31		
Mathematics	2387	163 and 179			31		
Mechanical_Engineering	410	87				52	
Medicine	1764	148			44		
Medicine_&_Health	7016	141			44		
Meteorology	66	173			38		
Microbiology	172	164			42		
Military	67	218					88
Models	1	266				50	
Modern_Art	8	5		20			
Multi_interdisciplinary_studies	178	219					81
Multimedia	514	100				53	
Music	580	11		24			
Music_History	99	12		24			
Music_Performance	91	14		24			
Music_Theory	96	13		24			
Networking	447	94				54	
Neurobiology	26	149			44		
Nuclear_Engineering	5	90			33		
Nutrition	329	153			42		
Office_&_Secretaria	71	225					85
Online_Teaching_&_Learning	3441	115					81
Operations_Management	337	60					85
Orthodontics	168	150 and 151			44		
Other	117	31	1				
Outdoors	45	226 and 267					76
Personal_&_Miscellaneous_Services	43	227					76
Philosophy	565	204	8				
Photography	43	6					76
Physical_Education	569	152 and 243					80
Physical_Sciences	304	165			42		
Physics	628	166			33		
Physiology	58	174			42		
Political_Science	562	205					89
Portugese	2	27		18			
Probability_&_Statistics	357	187			31		
Programming_Languages	638	101				54	
Project_Management	167	67					85
Property_Law	46	136					86
Psychology	2943	206					77
Public_Health	25	207			44		
Quality_Management	141	68					85
Radio_Scouting	1	253		20			
Reading	142	46		17			
Real_Estate	138	69 and 230					74
Religion	565	208	11				
Retail	23	70					83
Retirement_Planning	51	71					79
Risk_Management	20	72					85
ROTC (Reserve Officers Training Corps)	4	239					81
Russian	4	28		18			
Science	2158	155			30		
Sex_Education	7	246					81
Shop	24	240					83
Sign_Language	72	29		17			
Small_Business	73	73					83
Social_Sciences_or_Social_Study	3990	190					70
Social_Work	530	209					71
Society_&_Culture	203	220					71
Sociology	1217	210					71

Professions per ScienceClass	Total Courses	ID of CourseClass	Number of Institutes with the Course in the Curriculum				
			Gen.	Human.	Natural	Engineer.	Social
Software	3	254				54	
Spanish	757	30		18			
Speech	357	47		17			
Sports	146	247					76
Stamps	2	261					76
Stress_Management	3	74					85
Studio_Art_Drawing	30	10		21			
Studio_Art_Painting	20	8		21			
Studio_Art_Sculpture	9	9		21			
StudioArt	77	7		20			
System_Administration	193	102					85
Tax_Law	46	137					86
Taxes	46	75					88
Teacher_Training	1300	116					80
Technical_Support	103	103					85
Technical_Writing	67	104		17			
Theatre	170	16		24			
Time_Management	4	76					83
Torts (crime)	50	138					71
Toys	2	262					80
Travel	27	241					76
Trigonometry	107	186			31		
Vocational	1480	222					71
Wildlife	24	175			46		
Workplace_Safety	44	77					85
World_Civilizations	58	211					71
World_History	87	212		15			
Writing	959	48 and 268		17			
Zoology	55	176			46		
Total of 238 professions			**18**	**47**	**44**	**28**	**101**

12.10 APPENDIX J: OVERVIEW VLE COURSES AND COMMUNITIES

Owner	Courses & Comm's	Handles	Total Courses	Course Users	Total Comm's	Comm Users	Service Course	Total Users
Bb001	125	yes	29	155	95	948	1	1103
Bb002	3357	yes	3355	6156	1		1	6156
Bb003	2815	no	2790		24		1	
Bb004	208	yes	167	86	40	4	1	90
Bb005	473	no	471		1		1	
Bb006	13	yes	10	4	2		1	4
Bb007	8017	no	8016				1	
Bb008	1131	yes	1130	3742			1	3742
Bb009	18	yes	17	50			1	50
Bb010	27472	yes	27454	8876	17	360	1	9236
Bb011	694	yes	693	3586			1	3586
Bb012	147	yes	146	597			1	597
Bb013	4	yes	3	6			1	6
Bb014	1795	yes	1794	1986			1	1986
Bb015	312	yes	311	1008			1	1008
Bb016	32302	yes	32225	6905	76	449	1	7354
Bb017	9341	yes	9340	3065			1	3065
Bb018	2961	yes	2960	3181			1	3181
Bb019	14302	no	14007		294		1	
Bb020	2567	yes	2530	4077	36	90	1	4167
Bb021	827	yes	826	1971			1	1971
Bb022	616	yes	615	1037			1	1037
Bb023	873	yes	872	1896			1	1896
Bb024	1473	yes	1472	2169			1	2169
Bb025	288	yes	287	760			1	760
Bb026	22155	no	22073		81		1	
Bb027	1059	yes	1058	1208			1	1208
Bb028	1244	yes	1243	4529			1	4529
Bb029	26720	no	26697		22		1	
Bb030	932	yes	931	2970			1	2970
Bb031	6	yes	5				1	
Bb032	11139	no	10852		286		1	
Bb033	3399	yes	3337	2883	61	755	1	3638
Bb034	372	yes	371	2027			1	2027
Bb035	2249	yes	2209	864	39	104	1	968
Bb036	3928	no	3916		11		1	
Bb037	426	yes	425	1883			1	1883
Bb038	2177	yes	2175	2178	1		1	2178
Bb039	47746	no	47745				1	
Bb040	173	yes	172	21			1	21
Bb041	637	yes	631	1896	5	3	1	1899
Bb042	1455	yes	1393	2056	61	509	1	2565
Bb043	51	yes	50	21			1	21
Bb044	544	yes	543	1822			1	1822
Bb045	2306	yes	2305	540			1	540
Bb046	892	yes	875	6526	16	204	1	6730
Bb047	2499	yes	2407	3685	91	555	1	4240
Bb048	2265	no	2264				1	
Bb049	416	yes	415	633			1	633
Bb050	14	yes	13	23			1	23
Bb051	107571	no	107465		105		1	
Bb052	1568	yes	1567	4471			1	4471
Bb053	2112	no	2076		35		1	
Bb054	1814	yes	1813	4047			1	4047
Bb055	1158	yes	1157	5058			1	5058
Bb056	36	no	35				1	
Bb057	207	yes	206	395			1	395
Bb058	9544	no	9542		1		1	
Bb059	3968	yes	3966	9900	1		1	9900
Bb060	3372	yes	3325	3922	46	242	1	4164
Bb061	49286	no	49286				0	
Bb062	1533	no	1531		1		1	
Bb063	13110	no	13093		16		1	
Bb064	356	yes	349	498	6	18	1	516
Bb065	326	yes	325	2303			1	2303
Bb066	1664	yes	1663	5566			1	5566
Bb067	1998	yes	1953	3262	44	271	1	3533
Bb068	3970	yes	3969	3612			1	3612

Owner	Courses & Comm's	Handles	Total Courses	Course Users	Total Comm's	Comm Users	Service Course	Total Users
Bb069	260	yes	259	413			1	413
Bb070	8531	yes	8456	5015	74	111	1	5126
Bb071	273	yes	272	117			1	117
Bb072	236	yes	231	924	4	19	1	943
Bb073	859	yes	858	2047			1	2047
Bb074	68870	no	68868		1		1	0
Bb075	205	yes	204	14			1	14
Bb076	25	yes	24	7			1	7
Bb077	4425	no	4377		47		1	0
Bb078	47	yes	43	1	3		1	1
Bb079	7417	no	7414		2		1	0
Bb080	540	yes	539	1480			1	1480
Bb081	28378	no	28238		139		1	0
Bb082	4892	no	4891				1	0
Bb083	141	yes	116	1013	24	678	1	1691
Bb084	3533	no	3532				1	0
Bb085	1417	yes	1342	2041	74	537	1	2578
Bb086	268	yes	265	1114	2		1	1114
Bb087	19643	yes	19630	583	12	31	1	614
Bb088	5823	no	5793		29		1	0
Bb089	386	yes	383	876	2		1	876
Bb090	5938	no	5937				1	0
Bb091	902	yes	901	1549			1	1549
Bb092	1784	no	1783				1	0
Bb093	55	yes	41	268	13	49	1	317
Bb094	2871	yes	2870	2000			1	2000
Bb095	3026	yes	3026	2952			0	2952
Bb096	548	yes	547	49			1	49
Bb097	1127	yes	1126				1	0
Bb098	89	yes	88	299			1	299
Bb099	624	yes	623	3582			1	3582
Bb100	855	yes	854	3455			1	3455
Bb101	1330	yes	1329	4406			1	4406
Bb102	1912	yes	1901	2552	10	24	1	2576
Bb103	9602	yes	9069	5636	532	1012	1	6648
Bb104	248	no	232		15		1	0
Bb105	4381	no	4299		81		1	0
Bb106	27	yes	269	882			1	882
Bb107	2314	no	2308		5		1	0
Bb108	1445	yes	1444	4998			1	4998
Bb109	1708	no	1704		3		1	0
Bb110	8324	no	8182		141		1	0
Bb111	6190	no	6189				1	0
Bb112	754	no	753				1	0
Bb113	17294	no	17158		135		1	0
Bb114	310	yes	100	775	209	2331	1	3106
Bb115	374	yes	373	2003			1	2003
Bb116	309	yes	281	1014	27	146	1	1160
Bb117	179	yes	121	390	57	185	1	575
Bb118	978	no	973		4		1	0
Bb119	38	yes	37	2			1	2
Bb120	148	yes	147	238			1	238
Bb121	11098	yes	11097	7515			1	7515
Bb122	227	yes	225	126	1	6	1	132
Bb123	3019	yes	3018	4313			1	4313
Bb124	432	yes	431	712			1	712
Bb125	1618	yes	1617	3617			1	3617
Bb126	2024	yes	2023	2557			1	2557
Bb127	1618	yes	1615	1056	2		1	1056
Bb128	2335	no	2334				1	0
Bb129	849	no	848				1	0
Bb130	8355	yes	8354	4539			1	4539
Bb131	633	yes	632	2882			1	2882
Bb132	2319	no	2318				1	0
Bb133	719	yes	718	2112			1	2112
Bb134	1266	no	1263		2		1	0
Bb135	598	yes	593	1718	4	75	1	1793
Bb136	2068	no	2067				1	0
Bb137	296	yes	295	653			1	653
Bb138	damaged							
Bb139	3464	no	3463				1	0
Bb140	1285	yes	1284	1818			1	1818
Bb141	38800	no	38532		267		1	0

Owner	Courses & Comm's	Handles	Total Courses	Course Users	Total Comm's	Comm Users	Service Course	Total Users
Bb142	16199	yes	15821	5350	377	389	1	5739
Bb143	2607	no	2606				1	0
Bb144	128	yes	127	448			1	448
Bb145	1484	yes	1483	1374			1	1374
Bb146	946	yes	945	5188			1	5188
Bb147	500	yes	411	2661	88	873	1	3534
Bb148	2256	no	2255				1	0
Bb149	936	yes	935	1622			1	1622
Bb150	1110	no	1105		4		1	0
Bb151	24094	no	23883		210		1	0
Bb152	140	yes	139	1535			1	1535
Bb153	9102	no	9101				1	0
Bb154	566	yes	565	857			1	857
Bb155	53735	no	53720		14		1	0
Bb156	1901	yes	1900	2312			1	2312
Bb157	789	yes	788	1740			1	1740
Bb158	178	yes	177	807			1	807
Bb159	6603	no	6543		59		1	0
Bb160	323	yes	310	947	12	160	1	1107
Bb161	63	yes	62	1153			1	1153
Bb162	617	yes	616	3356			1	3356
Bb163	5361	yes	5321	2271	39	3	1	2274
Bb164	10587	no	10579		7		1	0
Bb165	2793	yes	2792	602			1	602
Bb166	1057	yes	1056	6737			1	6737
Bb167	43	yes	42	91			1	91
Bb168	378	yes	377	1098			1	1098
Bb169	8830	no	8820		9		1	0
Bb170	482	yes	481	886			1	886
Bb171	191	yes	190	2285			1	2285
Bb172	2673	no	2672				1	0
Bb173	47	yes	45	216	1		1	216
Bb174	3213	yes	3203	3644	9	13	1	3657
Bb175	damaged							
Bb176	33	yes	32	14			1	14
Bb177	827	yes	755	2385	71	370	1	2755
Bb178	2850	yes	2849	3049			1	3049
Bb179	1410	yes	1408	5137			2	5137
Bb180	224	yes	169	123	54	59	1	182
Bb181	1	yes	0				1	0
Bb182	7871	no	7832		38		1	0
Bb183	2734	yes	2730	8570	3	54	1	8624
Bb184	1528	yes	1527	5230			1	5230
Bb185	455	yes	454	1131			1	1131
Bb186	1238	yes	1237	4058			1	4058
Bb187	514	yes	513	733			1	733
Bb188	8857	no	8817		39		1	0
Bb189	59	yes	58	504			1	504
Bb190	1	yes	0				1	0
Bb191	101	yes	100	372			1	372
Bb192	83	yes	82	120			1	120
Bb193	95	yes	55	304	39	317	1	621
Bb194	3217	no	3214		2		1	0
Bb195	23	yes	22	229			1	229
Bb196	22	yes	21	56			1	56
Bb197	9425	no	9424				1	0
Bb198	541	yes	540	422			1	422
Bb199	40	yes	39	23			1	23
Bb200	damaged							
Bb201	1	yes	0				1	0
Bb202	16	yes	15	13			1	13
Bb203	18	yes	17	11			1	11
Bb204	47	yes	45	15	1	1	1	16
Bb205	102	yes	101	298			1	298
Bb206	12911	no	12910				1	0
Bb207	11577	yes	11576	6958			1	6958
Bb208	377	yes	376	5871			1	5871
Bb209	3328	yes	3327	3396			1	3396
Bb210	7	yes	4	4	2	2	1	6
Bb211	16	yes	15	43			1	43
Bb212	190	yes	189	872			1	872
Bb213	12069	no	12052		16		1	0
Bb214	33	yes	32	177			1	177

Owner	Courses & Comm's	Handles	Total Courses	Course Users	Total Comm's	Comm Users	Service Course	Total Users
Bb215	29	yes	26	17	2		1	17
Bb216	1308	yes	1307	3706			1	3706
Bb217	830	yes	829	4566			1	4566
Bb218	59	yes	58	58			1	58
Bb219	2894	no	2852		41		1	0
Bb220	2669	yes	2642	3605	26	448	1	4053
Bb221	4702	no	4592		109		1	0
Bb222	4075	yes	4004	2396	70	274	1	2670
Bb223	42	yes	41	175			1	175
Bb224	45	yes	44	383			1	383
Bb225	49	yes	47	195	1	1	1	196
Bb226	36	yes	33	98	2	2	1	100
Bb227	20191	no	19879		311		1	0
Bb228	156	yes	155	748			1	748
Bb229	12	yes	11	14			1	14
Bb230	10	yes	9	1			1	1
Bb231	216	yes	215	707			1	707
Bb232	256	yes	255	438			1	438
Bb233	719	yes	681	302	37	2	1	304
Bb234	694	yes	694	1713			0	1713
Bb235	2	yes	0		1	13	1	13
Bb236	1596	yes	1593	7316	2	1	1	7317
Bb237	2	yes	0		1	1	1	1
Bb238	2839	yes	2838	1549			1	1549
Bb239	1	yes	0				1	0
Bb240	3832	yes	3831	2018			1	2018
Bb241	2	yes	0		1		1	0
Bb242	40	yes	39	72			1	72
Bb243	1603	yes	1602	304			1	304
Bb244	203	yes	202	1207			1	1207
Bb245	1517	yes	1516	2611			1	2611
Bb246	5	yes	3	16	1	1	1	17
Bb247	76	yes	75	335			1	335
Bb248	409	yes	408	2801			1	2801
Bb249	79	yes	78	1030			1	1030
Bb250	24	yes	23	294			1	294
Bb251	2	yes	1	2			1	2
Bb252	21405	yes	21396	6571	8	7	1	6578
Bb253	70	yes	69	410			1	410
Bb254	4	yes	1		2	7	1	7
Bb255	3	yes	2				1	0
Bb256	181	yes	180	87			1	87
Bb257	235	yes	234	1345			1	1345
Bb258	783	yes	753	188	29	30	1	218
Bb259	9328	no	9207		120		1	0
Bb260	1106	yes	1105	1462			1	1462
Bb261	37	yes	36	33			1	33
Bb262	2191	yes	2136	40	54	5	1	45
Bb263	3169	yes	3159	117	9	29	1	146
Bb264	damaged							
Bb265	8	yes	7	3			1	3
Bb266	82	yes	81	96			1	96
Bb267	1	yes	0				1	0
Bb268	22131	no	22049		81		1	0
Bb269	4791	yes	4790	2319			1	2319
Bb270	392	yes	386	258	5	41	1	299
Bb271	43	yes	42	125			1	125
Bb272	3	yes	2	1			1	1
Bb273	1	yes	0				1	0
Bb274	2	yes	1	1			1	1
Bb275	1582	yes	1562	1095	19	107	1	1202
Bb276	24	yes	23	1			1	1
Bb277	149	yes	119	71	29	7	1	78
Bb278	3	yes	2	12			1	12
Bb279	1	yes	0				1	0
Bb280	49390	no	49390				0	0
Bb281	28321	no	28181		139		1	0
Bb282	2	yes	1	1			1	1
Bb283	5858	no	5851		6		1	0
Bb284	1	yes	0				1	0
Bb285	3247	yes	2846	15312	400	5903	1	21215
Bb286	4224	yes	4052	15929	171	560	1	16489
Bb287	7393	yes	7104	34109	288	2731	1	36840

Owner	Courses & Comm's	Handles	Total Courses	Course Users	Total Comm's	Comm Users	Service Course	Total Users
Bb288	6153	yes	5934	17227	218	4224	1	21451
Bb289	2367	yes	2088	10766	278	2997	1	13763
Bb290	5049	yes	5045	23216	3	84	1	23300
Bb291	27313	yes	10385	11371	16927	7526	1	18897
Bb292	7660	yes	7443	24916	216	1943	1	26859
Bb293	2929	yes	2841	11705	87	680	1	12385
Totals	1277276	223	1252766	531187	24224	39581	286	570768

Totals Courses & Communities is sum of Active Courses, Active Communities and Service Courses
Handles indicates Courses and Communities with activity handles logged
Active Courses indicate courses where students made educational activities
Course Users present the number of Users enrolled in the Courses
Active Communities indicates communities where students made educational activities
Community Users present the number of Users enrolled in the Communities
Service Courses are administrator's test courses
Total Active Users is sum of Course Users and Community Users
Lifetime VLE is derived from first and last timestamps of the VLE's courses

12.11 APPENDIX K: SPSS SYNTAX SCRIPTS

Script 7: Example of SPSS Syntax to Query the Research Base

```
* In order to present the Indicator ...
  we load the ... from the Research Base.
GET DATA
/TYPE=ODBC
/CONNECT='DSN=Pietzijndata;Description=BlackboardData;UID=;APP=SPSS  For  Windows;'+
'WSID=PHD_PIETZ;DATABASE=Pietzijndata;Trusted_Connection=Yes'
/SQL= " SELECT "
* Variables and Table names follow hereunder dependent on the search.
* .............................................................. .

* The different institutes are recoded into Further Education ... .
* ... to make a distribution over 4 InstituteClasses, which are ... .
* ... K12, Higher Education, Further Education, and Corporation.
RECODE
  InstituteClass
  ('Weiterbildung' = 'Further Education')
  ('Continuing Education' = 'Further Education')
  ('Educacin hasta 18 aos' = 'Further Education')
  ('Educacin superior' = 'Further Education')
  ('Formacin continua' = 'Further Education')
  ('Professional Association' = 'Further Education')
  ('Professional Education' = 'Further Education') .
EXECUTE .

* The Dutch universities are recoded into Bb285 to Bb293.
```

Script 8: SPSS Syntax to Obtain Number of Communities and Courses

```
/SQL= " SELECT "
   " Substring (T0.DTCreatedWeka,1,7) AS YearMonth, "
   " T0.ServiceLevel AS ServiceClass, "
   " T0.Institute AS Owner, "
   " T1.RegistryValue AS InstituteClass "
   " FROM dbo.CourseMain T0, dbo.SystemRegistry T1 "
   " WHERE T0.Institute = T1.Institute "
   " AND (T1.RegistryKey = 'Institution_Type') "
/ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Ind_No_FandC WINDOW=FRONT.

* PATH FOR COMMUNITIES. First select the communities 'C' only.
* To discern the ServiceClass we put a filter for Communities C.
USE ALL.
COMPUTE filter_$=(ServiceClass = 'C').
VARIABLE LABEL filter_$ "ServiceClass = 'C' (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
```

```
* For presenting an overview with box plots we have to determine the totals with
  so-called CUSTOM TABLES, which are exported to Excel for further processing.
* In the 1st row InstituteClass, in the 2nd Owner, and in the 3rd Totals.
CTABLES
  /VLABELS VARIABLES=InstituteClass Owner DISPLAY=DEFAULT
  /TABLE InstituteClass > Owner [COUNT F40.0]
  /CATEGORIES VARIABLES=InstituteClass Owner ORDER=A KEY=VALUE EMPTY=EXCLUDE.
* Export the CTABLE to file "Ind_No_C.xls".
* Modify the table in Excel. Delete redundant columns and rows.
* Be aware that no empty cells remain; i.e. copy the InstituteClass cells.


* Load the Excel sheet Ind_No_C.xls.
GET DATA
  /TYPE=XLS
  /FILE='D:\Documents and Settings\PietZ\Bureaublad\Ind_No_C.xls'
  /SHEET=name 'Sheet0'
  /CELLRANGE=full
  /READNAMES=on
  /ASSUMEDSTRWIDTH=32767.
DATASET NAME Ind_No_C WINDOW=FRONT.

* Make sure that the Totals are weighed.
* SPSS must know that Totals are real numbers to calculate with them.
WEIGHT BY Totals.

* Organise the Box Plot. With a box plot multiple indicators are calculated.
EXAMINE VARIABLES=Totals BY InstituteClass
  /PLOT=BOXPLOT
  /COMPARE GROUP
  /PERCENTILE (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /MISSING LISTWISE.

* Now repeat the same steps for Courses i.e. PATH for F.
* Every C is to be replaced with F;  C → F.
* Ind_No_C → Ind_No_F.
```

Script 9: SPSS Syntax to Obtain number of VCs and OLCs

```
* This syntax is to determine the number of VCs and OLCs.
* Determine unique communities and courses from the Handle table.
  /SQL="SELECT "
    "T0.ServiceLevel AS ServiceClass, T0.Institute AS Owner,"
    "T1.RegistryValue AS InstituteClass, T2.Course, T2.Role AS UserClass "
    "FROM dbo.CourseMain T0, dbo.SystemRegistry T1, dbo.Handle T2 "
    "WHERE T0.Course = T2.Course and "+
    "T0.Institute = T2.Institute and T0.Institute = T1.Institute "+
    "and T2.Institute = T1.Institute "+
    "and T1.RegistryKey = 'institution_type'"
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Ind_OLCandVC WINDOW=FRONT.

* Identify Duplicate Cases.
```

```
* At first, sort the equal courses per institute.
SORT CASES BY Course(A) Owner(A).
* Find the number of equal appearances per course.
* We only want just one unique course out of the number of handles per course.
MATCH FILES
  /FILE=*
  /BY Course
  /LAST=PrimaryLast.
VARIABLE LABELS  PrimaryLast 'Indicator last matching case'.
VALUE LABELS  PrimaryLast 1 'Primary Case' 0 'Duplicate Case'.
VARIABLE LEVEL  PrimaryLast (ORDINAL).
EXECUTE.

* Because we want to present an overview with box plots we have to
  determine the totals with a custom table and export to Excel.
* In 1st row InstituteClass, in 2nd Owner, next the communities tables
  where in subtables the duplicates, unique ones and totals followed
  by course tables and totals.
CTABLES
  /VLABELS VARIABLES=InstituteClass Owner ServiceClass PrimaryLast DISPLAY=DEFAULT
  /TABLE InstituteClass [C] > Owner [C] BY ServiceClass [C] > PrimaryLast [C][COUNT
F40.0]
  /CATEGORIES VARIABLES=InstituteClass ORDER=A KEY=VALUE EMPTY=EXCLUDE
  /CATEGORIES VARIABLES=Owner ORDER=A KEY=VALUE EMPTY=EXCLUDE
  /CATEGORIES  VARIABLES=ServiceClass  ORDER=A  KEY=VALUE  EMPTY=EXCLUDE  TOTAL=YES
POSITION=AFTER
  /CATEGORIES  VARIABLES=PrimaryLast  ORDER=A  KEY=VALUE  EMPTY=EXCLUDE  TOTAL=YES
POSITION=AFTER.
* Export the CTABLE to "Ind_No_OLCandVC.
* Edit the table in Excel. Delete redundant columns and rows.
* Be aware that no empty cells remain, i.e. copy and fill the InstituteClass cells.

* Compose an overview of the totals within Ind_No_C.xls and Ind_No_F.xls.
* Take the C_Uniques and F_Uniques from Ind_No_OLCandVC.
* Create new tables and name them VC0 and OLC0, Ratio_VC and Ratio_OLC.
* The VC0 and OLC0 are calculated by subtraction.
* In order to obtain the Ratios for the next indicator they are calculated by
  The division of C_Uniques by C_Totals, and F_Uniques by F_Totals.
  Rename C_ and F_Uniques into VC and OLC resp.

* Now the presentation of the indicators.
* First the VC_Totals which are Communities with seat time activities.
* Load the Excel sheet and rename dataset into Ind_VC.
GET DATA
  /TYPE=XLS
  /FILE='D:\...\Ind_No_C.xls'
  /SHEET=name 'Sheet0'
  /CELLRANGE=full
  /READNAMES=on
  /ASSUMEDSTRWIDTH=32767.
DATASET NAME Ind_VC WINDOW=FRONT.
* Because SPSS can only weight 1 variable (column) with figures at the same time
  we have to process in sequences.
* Calculate box plot and descriptives, then VC0, and Ratio_VC.

* Present an overview of the valid values.
CTABLES
```

```
  /VLABELS VARIABLES=InstituteClass C_Totals VC_Totals VC0 Ratio_VC DISPLAY=DEFAULT
  /TABLE InstituteClass [C] BY C_Totals [S][VALIDN F40.0] + VC_Totals [S][VALIDN
F40.0] + VC0 [S][VALIDN F40.0] + Ratio_VC [S][VALIDN F40.0]
  /CATEGORIES VARIABLES=InstituteClass ORDER=A KEY=VALUE EMPTY=EXCLUDE TOTAL=YES
POSITION=AFTER.

* The VC_Totals.
WEIGHT BY VC_Totals.
* Deselect the outlier Bb291 for presentation purposes.
USE ALL.
COMPUTE filter_$=(Owner <> 'Bb291').
VARIABLE LABEL filter_$ "Owner <> 'Bb291' (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
* Organise the BoxPlot.
EXAMINE VARIABLES=VC_Totals BY InstituteClass
  /PLOT=BOXPLOT
  /STATISTICS=NONE
  /NOTOTAL.
* Use all cases again.
FILTER OFF.
USE ALL.
EXECUTE.
* Calculate descriptives.
MEANS TABLES=VC_Totals BY InstituteClass
  /CELLS COUNT MEDIAN MEAN STDDEV MIN MAX.

* The VC0 (non-communities).
WEIGHT BY VC0.
* Deselect the outlier Bb291 for presentation purposes.
USE ALL.
COMPUTE filter_$=(Owner <> 'Bb291').
VARIABLE LABEL filter_$ "Owner <> 'Bb291' (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
* Organise the BoxPlot.
EXAMINE VARIABLES=VC0 BY InstituteClass
  /PLOT=BOXPLOT
  /STATISTICS=NONE
  /NOTOTAL.
* Use all cases again.
FILTER OFF.
USE ALL.
EXECUTE.
* Calculate descriptives.
MEANS TABLES=VC0 BY InstituteClass
  /CELLS COUNT MEDIAN MEAN STDDEV MIN MAX.

* The Ratio_VC.
WEIGHT BY Ratio_VC.
* Organise the BoxPlot.
EXAMINE VARIABLES=Ratio_VC BY InstituteClass
  /PLOT=BOXPLOT
```

```
  /STATISTICS=NONE
  /NOTOTAL.
* Calculate descriptives.
MEANS TABLES=Ratio_VC BY InstituteClass
  /CELLS COUNT MEDIAN MEAN STDDEV MIN MAX.

* Repeat the steps for the OLC_Totals, OLC0 (non-courses), and Ratio_OLC.
```

Script 10: SPSS Syntax to Obtain Number of Users from Handle Table

```
/SQL= "SELECT"
   " T0.ServiceLevel AS ServiceClass, T0.Institute AS Owner, T1.RegistryValue AS "
   " InstituteClass, T2.Role AS UserClass, T2.UserId, "
   " SUBSTRING(T2.TimestampWeka,1,7) AS YearMonth"
   " FROM dbo.CourseMain T0, dbo.SystemRegistry T1, dbo.Handle T2 "
   " WHERE T0.Course = T2.Course and T0.Institute = T2.Institute "
   " AND T0.Institute = T1.Institute and T2.Institute = T1.Institute "
   " AND (T1.RegistryKey = 'institution_type' )"
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Ind_no_Users WINDOW=FRONT.

* Identify Duplicate Cases for User_IDs for determining the number of unique users.
SORT CASES BY UserId(A) Owner(A).
MATCH FILES
  /FILE=*
  /BY UserId
  /FIRST=PrimaryFirst
  /LAST=Unique_User.
DO IF (PrimaryFirst).
COMPUTE  Number_Of_Actions=1-Unique_User.
ELSE.
COMPUTE  Number_Of_Actions=Number_Of_Actions+1.
END IF.
LEAVE  Number_Of_Actions.
FORMAT  Number_Of_Actions (f7).
COMPUTE  InDupGrp=Number_Of_Actions>0.
SORT CASES InDupGrp(D).
MATCH FILES
  /FILE=*
  /DROP=PrimaryFirst InDupGrp.
VARIABLE LABELS
  Unique_User 'last matching case'
  Number_Of_Actions 'Sequential count of matching cases'.
VALUE LABELS  Unique_User 0 'Duplicate Case' 1 'Primary Case'.
VARIABLE LEVEL  Unique_User (ORDINAL) /Number_Of_Actions (SCALE).
DESCRIPTIVES VARIABLES=Unique_User Number_Of_Actions
  /STATISTICS=MEAN STDDEV MIN MAX.
EXECUTE.

* Totals in custom table and export to Excel.
* The UserClass holds the type of user
* Filter on the VCs first.
USE ALL.
COMPUTE filter_$=(ServiceClass = 'C' AND Unique_User = 1).
```

```
VARIABLE LABEL filter_$ "ServiceClass = 'C' AND Unique_User = 1 (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
* And now the custom table to export to ind_No_Users_VC_Uniques.xls.
CTABLES
  /VLABELS VARIABLES=InstituteClass Owner UserClass DISPLAY=DEFAULT
  /TABLE InstituteClass > Owner [COUNT F40.0] BY UserClass
  /CATEGORIES   VARIABLES=InstituteClass   Owner   UserClass   ORDER=A   KEY=VALUE
EMPTY=EXCLUDE.

* Repeat for the OLCs and export to Ind_No_Users_OLC_Uniques.xls.

* We also want to know the mean number of actions per unique user.
* This table is exported to Ind_No_Users_VC_OLC_Mean.xls.
CTABLES
  /VLABELS    VARIABLES=Unique_User    UserClass    InstituteClass    ServiceClass
Number_Of_Actions
    DISPLAY=DEFAULT
  /TABLE Unique_User [C] > UserClass BY InstituteClass [C] > ServiceClass [C] >
Number_Of_Actions
    [S][MEAN, STDDEV]
  /CATEGORIES VARIABLES=Unique_User [1] EMPTY=INCLUDE
  /CATEGORIES  VARIABLES=UserClass  InstituteClass  ServiceClass  ORDER=A  KEY=VALUE
EMPTY=EXCLUDE.

* Load the Excel sheet for VC.
GET DATA
  /TYPE=XLS
  /FILE='D:\Documents and Settings\PietZ\Bureaublad\Ind_No_Users_VC_Uniques.xls'
  /SHEET=name 'Sheet0'
  /CELLRANGE=full
  /READNAMES=on
  /ASSUMEDSTRWIDTH=32767.
DATASET NAME IND_No_Users_VC WINDOW=FRONT.

* Make sure that Totals is weighted.
WEIGHT BY Totals.
* Repeat for OLC and Ind_No_Users_OLC_Uniques.xls.
```

Script 11: SPSS Syntax to Obtain Lifespans in Months from CourseMain Table

```
* To determine the Communities Lifespan the (DTModifed - DTCreated) is taken.
  /SQL="SELECT "
    "T0.Course, T0.DTCreated, T0.DTModified, T0.ServiceLevel AS ServiceClass, "
    "T0.Institute AS Owner, T1.RegistryValue AS InstituteClass "
    "FROM dbo.CourseMain T0, dbo.SystemRegistry T1 "
    "WHERE T0.Institute = T1.Institute and (T1.RegistryKey = 'institution_type')"
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Lifetime_FandC WINDOW=FRONT.

* Calculate the Lifetime.
COMPUTE CourseLifetime  =DATEDIFF(DTModified,DTCreated,"months").
```

```
EXECUTE.


EXAMINE VARIABLES=CourseLifetime BY InstituteClass
  /PLOT=BOXPLOT
  /COMPARE GROUP
  /PERCENTILE (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /MISSING LISTWISE.

* Repeat the steps for Courses.
```

Script 12: SPSS Syntax to Obtain Lifespans in Months from Handle Table

```
* This syntax is to determine the Lifetime of OLC and VC.
* Determine unique communities and courses in Handle table.
  /SQL= " SELECT "
    " T2.RegistryValue AS InstitutionClass, T0.Institute AS Owner, "
    " T0.ServiceLevel AS ServiceClass, T1.Course, T1.Timestamp "
    " FROM dbo.CourseMain T0, dbo.Handle T1, dbo.SystemRegistry T2 "
    " WHERE T0.Course = T1.Course and T0.Institute = T1.Institute "
    " and T0.Institute = T2.Institute and T1.Institute = T2.Institute "
    " and T2.RegistryKey = 'Institution_type' "
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Ind_Lifetime_VCandOLC WINDOW=FRONT.

* Identify Duplicate Cases. BE AWARE that sorting is very important.
* With "SORT CASES BY Course(A) Owner(A) Timestamp(A)" it sorts the courses over
  the owners with the result that first and last is determined for courses
  in general and not in courses per owner. We want to sort courses for every owner.
SORT CASES BY Owner(A) Course(A) Timestamp(A).
* Find the equal appearances of owners and courses.
MATCH FILES
  /FILE=*
  /BY Owner Course
  /FIRST=PrimaryFirst
  /LAST=PrimaryLast.
DO IF (PrimaryFirst).
COMPUTE  MatchSequence=1-PrimaryLast.
ELSE.
COMPUTE  MatchSequence=MatchSequence+1.
END IF.
LEAVE  MatchSequence.
FORMAT  MatchSequence (f7).
VARIABLE LABELS
   PrimaryLast 'Indicator last matching case'
   MatchSequence 'Sequential count of matching cases'.
VALUE LABELS  PrimaryLast 0 'Duplicate Case' 1 'Primary Case'.
VARIABLE LEVEL  PrimaryLast (ORDINAL) /MatchSequence (SCALE).
EXECUTE.

* We select only the MatchSequence, PrimaryFirst and PrimaryLast rows and delete
  the unselected cases in order to minimise the working dataset of 123 million
records and decreasing the processing time.
```

```
FILTER OFF.
USE ALL.
SELECT IF (PrimaryFirst = 1 OR PrimaryLast = 1 OR MatchSequence = 1).
EXECUTE.

* In order to calculate the CourseLength we need the FirstDate and LastDate within
  the same records.
* Create FirstDate as timestamp of the first action.
IF (PrimaryFirst = 1 AND PrimaryLast = 0) FirstDate = Timestamp.
* The LAG function is for copying 'timestamp' from an upper row into a lower row.
* The LEAD function is for copying a lower timestamp into an upper row.
* In that way we can calculate time differences between first and last timestamp.
CREATE LastDate = LEAD (Timestamp,1).
* Sometimes there are no duplicates or there was just 1 action with 1 date.
* Then the LAG or LEAD function must be overruled and the same record is used to
  fill the FirstDate. The courseLength will be 0 months in that case.
IF (MatchSequence = 0) FirstDate = Timestamp.
* And the same counts for the LastDate.
IF (MatchSequence = 0) LastDate = Timestamp.
* When Calculating with dates SPSS shows dates in seconds since midnight Oct 14th,
  1582. Show the DateTime fields not in numbers but in readable characters.
FORMATS FirstDate (SDATE11).
FORMATS LastDate (SDATE11).
EXECUTE.

* Select only rows where PrimaryFirst = 1 and remove other records to hold a
  Dataset with only the unique records.
FILTER OFF.
USE ALL.
SELECT IF (PrimaryFirst = 1).
EXECUTE.

* Calculate the CourseLength.
COMPUTE  CourseLength= RND(DATEDIFF(LastDate,FirstDate,"months")).
VARIABLE LABEL  CourseLength.
VARIABLE LEVEL  CourseLength (SCALE).
FORMATS  CourseLength (F5.0).
VARIABLE WIDTH  CourseLength (5).
EXECUTE.

* Show overview in box plots for VC and OLC.
* First VC.
USE ALL.
COMPUTE filter_$=(ServiceClass = 'C').
VARIABLE LABEL filter_$ "ServiceClass = 'C' (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
EXAMINE VARIABLES=CourseLength BY InstitutionClass
  /PLOT=BOXPLOT
  /PERCENTILES (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /NOTOTAL.

* To know how many handles a community has.
EXAMINE VARIABLES=MatchSequence BY InstitutionClass
```

```
  /PLOT=BOXPLOT
  /PERCENTILES (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /NOTOTAL.

* Finally OLC.
USE ALL.
COMPUTE filter_$=(ServiceClass = 'F').
VARIABLE LABEL filter_$ "ServiceClass = 'F' (FILTER)".
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
EXAMINE VARIABLES=CourseLength BY InstitutionClass
  /PLOT=BOXPLOT
  /PERCENTILES (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /NOTOTAL.

* To know how many handles a course has.
EXAMINE VARIABLES=MatchSequence BY InstitutionClass
  /PLOT=BOXPLOT
  /PERCENTILES (25,50,75)
  /STATISTICS=DESCRIPTIVES
  /NOTOTAL.
```

Script 13: SPSS Syntax for Nonlinear Regression Model to Estimate Gompertz Curve

```
* NonLinear Regression for HE_C. for
MODEL PROGRAM  a=1 b=3 c=.05.
COMPUTE  PRED_=a * Exp(-b * Exp(-c * Lifetime)).
NLR General_Sciences
  /PRED PRED_
  /CRITERIA SSCONVERGENCE 1E-8 PCON 1E-8.

* Repeat for all 5 ScienceClass Variables.
* Repeat for all 238 CourseClass Variables.
* Repeat for Courses HE_F.
```

Script 14: SPSS Syntax to Obtain Seat Time Duration from Handle Table

```
/SQL =
 'SELECT T1.ServiceLevel, T3.Role, T2.Duration FROM'
 'dbo.CourseMain T1, dbo.Handle T3, dbo.Duration T2 WHERE'
 'T3.Course = T1.Course and T3.Institute = T1.Institute'
 'and T2.Session = T3.Session and T2.Institute = T3.Institute'
* ServiceLevel is 'F' for Course or 'C' for Community.
* Role = '1' for Student, '2' for Faculty, and '3' for Staff.
 /ASSUMEDSTRWIDTH=255.
CACHE.

* Duration is recoded into 13 the DurCat variable
* because of calculation limitations of SPSS.
RECODE
  Duration (0 thru 5 = 1) (6 thru 10 = 2) (11 thru 15 = 3)
```

```
  (16 thru 30 = 4) (31 thru 45 = 5) (46 thru 60 = 6)
  (61 thru 90 = 7) (91 thru 120 = 8) (121 thru 180 = 9)
  (181 thru 240 = 10) (241 thru 480 = 11) (481 thru 720 = 12)
  (ELSE=13) INTO DurCat.
EXECUTE.
```

Script 15: SPSS Syntax to Obtain SessionTotals for Communities and Courses

```
GET DATA /TYPE=ODBC /CONNECT=
 'DSN=Pietzijndata;Description=BlackboardData;UID=;'
 'APP=SPSS For Windows;WSID=PHD_PIETZ;DATABASE=Pietzijndata;'
 'Trusted_Connection=Yes'
/SQL =
 'SELECT T1.ServiceLevel, T3.Role, T3.Session, T3.Handle,'
 'substring(TimestampWeka,12,2) as SeatTimeMoment, T2.Duration'
 'FROM  dbo.CourseMain T1, dbo.Handle T3, dbo.Duration T2'
 'WHERE T3.Course = T1.Course and T3.Institute = T1.Institute'
 'and T2.Session = T3.Session and T2.Institute = T3.Institute'
 'and (T1.ServiceLevel ='C' AND T3.Role ='1')'
 * ServiceLevel is 'F' for Course or 'C' for Community.
 * Role = '1' for Student, '2' for Faculty, and '3' for Staff.
 /ASSUMEDSTRWIDTH=255
 .
CACHE.
EXECUTE.

 * With Aggregate the duplicate cases can be determined.
 * With the BREAK command the total of duplicate cases are counted.
 * When OUTFILE is a star (*) then the active file is meant.
 * When "MODE=ADDVARIABLES" is used then the variables are added in a
 * new column. When not used the active dataset is replaced with the
 * new values and only the remaining cases appear.

AGGREGATE
  /OUTFILE=* MODE=ADDVARIABLES
  /BREAK=Session
  /SessionTotal=N.

  * The Scale variable SessionTotal must be a string or nominal variable
  * to be processed with CTABLES (Custom tables).
VARIABLE LEVEL SessionTotal (NOMINAL).

  * Custom Tables is to determine the ‘Mean’ and ‘Mode’ from duration of
  * session with number of handles.
CTABLES
  /VLABELS VARIABLES=Duration SessionTotal DISPLAY=DEFAULT
  /TABLE SessionTotal BY Duration [COUNT F40.0, MEAN, MODE]
  /CATEGORIES VARIABLES=SessionTotal ORDER=A KEY=VALUE EMPTY=EXCLUDE.

* The same code is repeated 6 times for the different subsets.
* T1.ServiceLevel = 'F' AND T3.Role = '1'.
* T1.ServiceLevel = 'F' AND T3.Role = '2'.
* T1.ServiceLevel = 'F' AND T3.Role = '3'.
* T1.ServiceLevel = 'C' AND T3.Role = '1'.
* T1.ServiceLevel = 'C' AND T3.Role = '2'.
* T1.ServiceLevel = 'C' AND T3.Role = '3'.
```

Script 16: SPSS Syntax to Obtain Seat Time Moment

```
* The ServiceLevel F stands for Course and the C for Community.
* The Role 1 stands for Student, 2 for Staff, and 3 for Faculty.
* For each of the selections F1, F2, F3, C1, C2, and C3
* the Duration is set out against the hour of the day
* At what time of the day are the longer or shorter sessions executed.

 /SQL =
  'SELECT  T1.ServiceLevel,  T3.Role,  T3.Session,  T3.Handle,'
  'substring(TimestampWeka,12,2) as SeatTimeMoment,  T2.Duration'
  'FROM  dbo.CourseMain T1, dbo.Handle T3, dbo.Duration T2'
  'WHERE T3.Course = T1.Course  and T3.Institute = T1.Institute'
  'and T2.Session = T3.Session and T2.Institute = T3.Institute'
  'and (T1.ServiceLevel = 'C' AND T3.Role = '1')'
 /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.

* Duration is recoded into 13 categories from the variable
* DurCat because of limitations of SPSS.
RECODE
  Duration (0 thru 5 = 1) (6 thru 10 = 2) (11 thru 15 = 3)
  (16 thru 30 = 4) (31 thru 45 = 5) (46 thru 60 = 6)
  (61 thru 90 = 7) (91 thru 120 = 8) (121 thru 180 = 9)
  (181 thru 240 = 10) (241 thru 480 = 11) (481 thru 720 = 12)
  (ELSE=13) INTO DurCat.
EXECUTE.

* The Scale variable DurCat must be a nominal for SPSS CTABLES.
VARIABLE LEVEL DurCat (NOMINAL).
* Custom Tables make overview of session's duration over 24 hours.
CTABLES
  /VLABELS VARIABLES = DurCat SeatTimeMoment DISPLAY=DEFAULT
  /TABLE SeatTimeMoment [COUNT F40.0] BY DurCat
  /CATEGORIES VARIABLES = DurCat SeatTimeMoment ORDER=A KEY=VALUE EMPTY=EXCLUDE
   TOTAL=YES POSITION=AFTER.

* The same code is repeated 6 times for the different subsets.
* T1.ServiceLevel = 'F' AND T3.Role = '1'.
* T1.ServiceLevel = 'F' AND T3.Role = '2'.
* T1.ServiceLevel = 'F' AND T3.Role = '3'.
* T1.ServiceLevel = 'C' AND T3.Role = '1'.
* T1.ServiceLevel = 'C' AND T3.Role = '2'.
* T1.ServiceLevel = 'C' AND T3.Role = '3'.
```

Script 17: SPSS Syntax to Obtain Seat Time Activities

```
/SQL =
 'SELECT T1.ServiceLevel, T3.Role, T3.Session, T3.Handle,'
 'substring(TimestampWeka,12,2) as SeatTimeMoment, T2.Duration'
 'FROM  dbo.CourseMain T1, dbo.Handle T3, dbo.Duration T2'
 'WHERE T3.Course = T1.Course and T3.Institute = T1.Institute'
```

```
 'and T2.Session = T3.Session and T2.Institute = T3.Institute'
 'and (T1.ServiceLevel ='F' AND T3.Role ='1' AND T1.Institute'
/ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.

AGGREGATE
  /OUTFILE=* MODE=ADDVARIABLES
  /BREAK=Session
  /SessionTotal=N.

VARIABLE LEVEL SessionTotal (NOMINAL).
  * Custom Tables to present the SessionTotals in the rows and Totals of
  * the Handles in the columns. Sorted by Number of Handles per session
  * and everything totalised.
CTABLES
  /VLABELS VARIABLES=Duration SessionTotal DISPLAY=DEFAULT
  /TABLE SessionTotal BY Duration [COUNT F40.0, MEAN, MODE]
  /CATEGORIES VARIABLES=SessionTotal ORDER=A KEY=VALUE EMPTY=EXCLUDE.

* The same code is repeated 6 times for the different subsets.
* T1.ServiceLevel = 'F' AND T3.Role = '1'.
* T1.ServiceLevel = 'F' AND T3.Role = '2'.
* T1.ServiceLevel = 'F' AND T3.Role = '3'.
* T1.ServiceLevel = 'C' AND T3.Role = '1'.
* T1.ServiceLevel = 'C' AND T3.Role = '2'.
* T1.ServiceLevel = 'C' AND T3.Role = '3'.
```

Script 18: SPSS Syntax to Obtain Seat Time Duration over Lifespan Years

```
  /SQL=
  ' SELECT '
  ' T0.Institute AS Owner, '+
  ' T2.RegistryValue AS InstituteClass, T3.Duration AS SeattimeDuration, '+
  ' T1."Timestamp" '
  ' FROM dbo.CourseMain T0, dbo.Handle T1, dbo.SystemRegistry T2, dbo.Duration T3 '
  ' WHERE T0.Institute = T3.Institute and T0.Course = T1.Course and '+
  ' T0.Institute = T1.Institute and T0.Institute = T2.Institute and T3.Institute =
    T1.Institute '+
  '  and  T3."Session"  =  T1."Session"  and  T3.Institute  =  T2.Institute  and
T1.Institute =
    T2.Institute and (T2.RegistryKey = ''institution_type'' AND T0.ServiceLevel =
 ''C'' AND T1.Role = ''1'' )'
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Hypothesis2_Lifetime WINDOW=FRONT.

*  Remove  the  Duration  that  are  larger  than  720  minutes  for  reliable  Mean  and
STDDEV.
FILTER OFF.
USE ALL.
SELECT IF (SeattimeDuration < 721).
EXECUTE.

SORT CASES BY Owner(A).
```

```
MATCH FILES /FILE=*
  /TABLE='DataSet1'
  /RENAME     (SystemLastMonth     NonHandleMonths     HandlesDuration     LifetimeVLE
NumberOfCourses
 LifetimeMonth
                  = d0 d1 d2 d3 d4 d5)
  /BY  Owner
  /DROP= d0 d1 d2 d3 d4 d5.
EXECUTE.
* The LifetimeMonth is the month since the very first startmonth of the first VLE.

* Select Higher Education only and delete the other cases.
FILTER OFF.
USE ALL.
SELECT IF (InstituteClass = 'Higher Education').
EXECUTE.

* Now it is time to calculate the time periods.
* The HandleMonth variable is the number of months since handlelogging.
COMPUTE HandleMonth = DATEDIFF(Timestamp,HandleStartMonth,"months").
EXECUTE.
* The NonHandle period (NonHandleMonths) is calculated by subtracting the ... .
* ... HandleStartMonth from the SystemStartMonth which are available in
InstituteTimes.sav.
COMPUTE NonHandleMonths = DATEDIFF(HandleStartMonth, SystemStartMonth,"months").
EXECUTE.
*  For  the  Lifetime  Month  on  the  X-Axis  we  must  take  the  SystemStartMonth  as
Lifetime
month 01.
* Lifetime = NonHandleMonths + HandleMonth.
COMPUTE Lifetime = NonHandleMonths + HandleMonth.
EXECUTE.

* Determine the Lifetime Year.
STRING LifetimeYear (A8).
RECODE  Lifetime  (0  thru  12='01')  (13  thru  24='02')  (25  thru  36='03')  (37  thru
48='04')
(49 thru 60='05') (61 thru 72='06') (73 thru 84='07') INTO LifetimeYear.
VARIABLE LABELS  LifetimeYear 'LifetimeYear'.
EXECUTE.

* Split the dataset over the Lifetime years and do the same descriptives for all.
SORT CASES  BY LifetimeYear.
SPLIT FILE LAYERED BY LifetimeYear.
DESCRIPTIVES VARIABLES=SeattimeDuration
  /STATISTICS=MEAN STDDEV MIN MAX.

* The same code is repeated 6 times for the different subsets.
* T1.ServiceLevel = 'F' AND T3.Role = '1'.
* T1.ServiceLevel = 'F' AND T3.Role = '2'.
* T1.ServiceLevel = 'F' AND T3.Role = '3'.
* T1.ServiceLevel = 'C' AND T3.Role = '1'.
* T1.ServiceLevel = 'C' AND T3.Role = '2'.
* T1.ServiceLevel = 'C' AND T3.Role = '3'.
```

Script 19: SPSS Syntax to Obtain Seat Time Activities over Lifespan Years

```
* The ServiceLevel F stands for Course and the C stands for Community
* The Role 1 stand for Student, 2 for Faculty, and 3 for Staff.
* For such reason 6 selections are to be collected. It cannot collect in one go
  because of the vast amount of data.

* For the Test Analysis of the Users' Uses we have to normalise the Calendar Time
into
  the ... .
* ... Lifetime Axis with Months as units. The LifetimeMonth from the Lifetime Axis
is
  calculated ... .
* ... starting with the Timestamp from the Handle or Activity. From the Timestamp
the
 ... .
* ... HandleStartMonth is subtracted to know the HandleMonth.
* From the InstituteTimes.sav the SystemStartMonth and HandleStartMonth are used
....
* ... to calculate the total delay, which is (CourseDelay + HandleDelay)
* The SystemStartMonth must become the very same as the first LifetimeMonth
  (01-01-1999).
* The NonHandleMonth = (CourseDelay + HandleDelay).
* The Lifetime = NonHandleMonths + HandleMonth.

  /SQL=
  ' SELECT '
  ' T0.Institute AS Owner, T0.ServiceLevel AS ServiceClass, T1.Role AS UserClass,
'+
  ' T2.RegistryValue AS InstituteClass, T1.Handle AS ActivityClass, T3.Duration AS
    SeattimeDuration, '+
  ' Substring(T1.TimestampWeka,12,2) AS SeattimeMoment, T1."Timestamp" '
  ' FROM dbo.CourseMain T0, dbo.Handle T1, dbo.SystemRegistry T2, dbo.Duration T3 '
  ' WHERE T0.Institute = T3.Institute and T0.Course = T1.Course and '+
  ' T0.Institute = T1.Institute and T0.Institute = T2.Institute and T3.Institute =
    T1.Institute '+
  ' and T3."Session" = T1."Session" and T3.Institute = T2.Institute and
T1.Institute =
  '+
  ' T2.Institute and (T2.RegistryKey = ''institution_type'' AND T0.ServiceLevel =
  ''C'' AND T1.Role = ''1'' )'
  /ASSUMEDSTRWIDTH=255.
CACHE.
EXECUTE.
DATASET NAME Hypothesis2_Lifetime WINDOW=FRONT.

SORT CASES BY Owner(A).

* For testing Hypothesis 2 we have to normalise the X-axis.
* For normalising the X-axis we need Variables from the InstituteTimes.sav file.
* OPEN the file InstituteTimes.sav.
* SELECT only the VLE's with values for HandleStartMonth.
USE ALL.
COMPUTE filter_$=(HandleStartMonth  >= 0).
VARIABLE LABEL filter_$ 'HandleStartMonth  >= 0 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMAT filter_$ (f1.0).
```

```
FILTER BY filter_$.
EXECUTE.
* There are 171 Owners selected.

* IMPORTANT: Be sure that string lengths on the BY command are equal.
* CHECK if the lengths of both Owner string variables are 8 characters long.
* The InstituteTimes.sav is to be matched with this current dataset.
*  Therefore  it  is  important  to  select  the  working  file  in  stead  of  the
Institute.sav
  file.
* SELECT the working file.
* For doing the match the order is very important (1 case from institute for many
  cases of this file).

MATCH FILES /FILE=*
  /TABLE='DataSet1'
  /RENAME    (SystemLastMonth    NonHandleMonths    HandlesDuration    LifetimeVLE
NumberOfCourses
   LifetimeMonth
                  = d0 d1 d2 d3 d4 d5)
  /BY  Owner
  /DROP= d0 d1 d2 d3 d4 d5.
EXECUTE.
* The LifetimeMonth is the month since the very first startmonth of the first VLE.

* Select Higher Education only and delete the other cases.
FILTER OFF.
USE ALL.
SELECT IF (InstituteClass = 'Higher Education').
EXECUTE.

* Now it is time to calculate the time periods.
* The HandleMonth variable is the number of months since handlelogging.
COMPUTE HandleMonth = DATEDIFF(Timestamp,HandleStartMonth,"months").
EXECUTE.
* The NonHandle period (NonHandleMonths) is calculated by subtracting the ... .
* ... HandleStartMonth from the SystemStartMonth which are available in
  InstituteTimes.sav.
COMPUTE NonHandleMonths = DATEDIFF(HandleStartMonth, SystemStartMonth,"months").
EXECUTE.
*  For  the  Lifetime  Month  on  the  X-Axis  we  must  take  the  SystemStartMonth  as
Lifetime
  month 01.
* Lifetime = NonHandleMonths + HandleMonth.
COMPUTE Lifetime = NonHandleMonths + HandleMonth.
EXECUTE.
* CHECK if all values all satisfactorily.
FREQUENCIES VARIABLES=HandleMonth Lifetime
  /ORDER=ANALYSIS.

* Now we will recode the SeattimeDuration into the 13 categories.
RECODE
  SeattimeDuration   (0  thru  5=1)   (6  thru  10=2)   (11  thru  15=3)   (16  thru  30=4)
(31
  thru 45=5)  (46 thru 60=6)  (61 thru 90=7)  (91 thru 120=8)  (121 thru
  180=9)  (181 thru 240=10)  (241 thru 480=11)  (481 thru 720=12)  (ELSE=13)  .
EXECUTE .
```

```
* The SCALE variables Lifetime and SeattimeDuration must be NOMINAL for Custom
Tables.
VARIABLE LEVEL Lifetime (NOMINAL).
VARIABLE LEVEL SeattimeDuration (NOMINAL).
* Table SeattimeDuration versus Lifetime.
CTABLES
  /VLABELS VARIABLES=SeattimeDuration Lifetime DISPLAY=DEFAULT
  /TABLE SeattimeDuration BY Lifetime [COUNT F40.0]
  /CATEGORIES VARIABLES=SeattimeDuration Lifetime ORDER=A KEY=VALUE EMPTY=EXCLUDE.
* Table SeattimeMoment versus Lifetime.
CTABLES
  /VLABELS VARIABLES=SeattimeMoment Lifetime DISPLAY=DEFAULT
  /TABLE SeattimeMoment BY Lifetime [COUNT F40.0]
  /CATEGORIES VARIABLES=SeattimeMoment Lifetime ORDER=A KEY=VALUE EMPTY=EXCLUDE.
* Table ActivityClass versus Lifetime.
CTABLES
  /VLABELS VARIABLES=ActivityClass Lifetime DISPLAY=DEFAULT
  /TABLE ActivityClass BY Lifetime [COUNT F40.0]
  /CATEGORIES VARIABLES=ActivityClass Lifetime ORDER=A KEY=VALUE EMPTY=EXCLUDE.

* And now for C2, C3, F1, F2, F3.
```

13 Curriculum Vitae

A.H.W. (Piet) van der Zanden was born in Delft on June 24, 1959. After graduating from the Anton Rosdorf Middelbare Technische School in The Hague in 1980 he obtained a vocational job as electronic engineer at the Institute of Applied Sciences (TNO) for Ground Water Survey. In the evening hours he started a higher vocational training in electronics at the polytechnic institute PBNA for distance learning in Arnhem.

In 1984 he switched from designing and developing electronical instruments to working with seismic exploration services at Delft Geophysical where he worked as a seismology instrument operator and head of the electronic departments throughout the country. In depth training at Sercel in France for the seismic recorder and his background as an electronic engineer made him a specialist in seismic instruments.

After graduating in 1986 with a Bachelor in Electronics, Piet moved to Leyenburg Hospital in The Hague to work as head of the diagnostic systems department and as the safety manager responsible for electric hazards and radiation exposure throughout the hospital. At the time Piet became the leading specialist in the Netherlands for eye laser equipment.

In 1990 Piet graduated as a Bachelor in Business Administration and switched his work to become manager at the PC Networking Group at Delft University of Technology (DUT) where he has worked as a consultant in the field of IT in organisations since 1995.
Piet has also worked as counsellor on strategic studies and application of ICT within complex organisations, covering organisational settings for business communication, cooperation and application of IT supported educational processes. Piet instigated cooperation between university service departments that used IT supported educational processes and teacher training in 1998.

In 2000 Piet was asked to participate in the ICT in Education Bureau at DUT to stimulate ICT use in education projects at the faculties, to give advice and to assess proposals, to monitor and evaluate ICT in education projects and to develop further the ICT in education policy programme at the Delft University of Technology. Piet has been a steering member of the E-merge cooperation program since 2002, a collaborative network of universities. In the same year he started his PhD research on top of his daily operations to combine the insights obtained from both the IT and ICT in Education domains.

Today Piet acts as a project leader in several inter-university programs and plays an instigating role in innovation studies for higher education, such as promoting the learning centre and next generation classroom.

The Facilitating University

Higher education is directly and indirectly subjected to pressures of diminishing subsidies, increasing student populations, labour demands, proliferation of technology, and new educational approaches and practices. Higher education must change to cope with these pressures.

This study is aimed at how higher education might cope with the current and upcoming pressures of technology on education. Developments that have had or have an influence in the shaping process of higher education were addressed, a quantitative study on growth patterns and users' uses from 289 virtual learning environments was conducted, and elaboration on educational technology with the gained insights was carried out to deliver a picture of the future educational practice, which we like to call *Learning mall*.

This study ends with seven key principles as a 'management-set' to start organising discussions and arrangements for a facilitating university to be at a vanguard position.

Piet van der Zanden (1959) is advisor in the field of ICT in higher education. He acts as a project leader in (inter)-university programs and plays an instigating role in innovative studies for higher education, such as learning centre and next generation classroom.

www.eburon.nl