

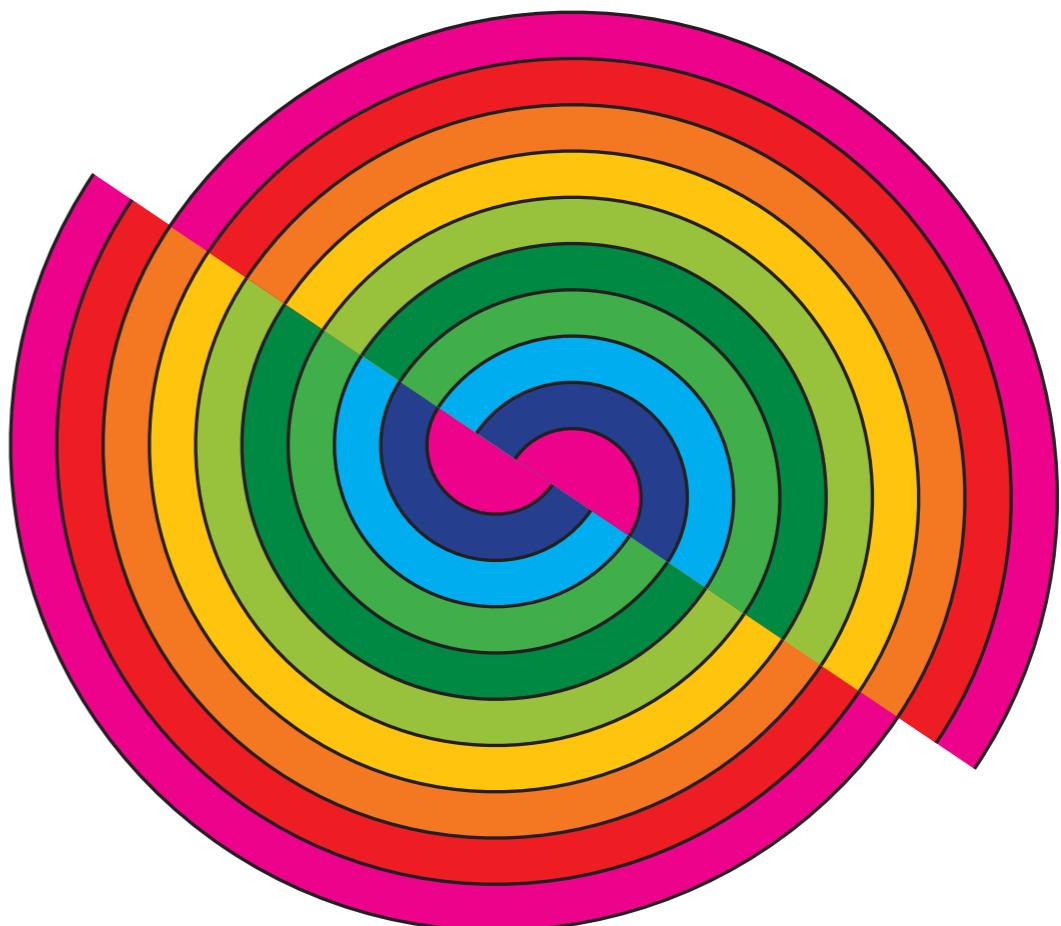
Many academic organisations are calling attention to the need for urgent changes in curricula and learning methods demanded by the continual social transformation of an increasingly technological world. Transversal skills such as the ability to think creatively and critically, take initiative, and work collaboratively for common goals, are essential to guarantee a qualified and entrepreneurial workforce in Europe. The D-Think research project emerged in this educational context during September 2014. It is an initiative of 7 partners from 6 different European countries, supported by the Erasmus+ Programme of the European Commission. The project aims to promote a wider use of Design Thinking as a transversal learning tool by developing and making available a toolkit and an innovative digital course for educators and professional trainers.

The result of the first year of the D-Think project is a **Research Report** about Design Thinking and its application in Education and Training, providing a **spring board** for the next stages of the project: the creation of the D-Think toolkit and the D-Think m-learning course, both in development and testing until August 2017.

The main objective of the Research Report is the clarification of the **role of Design Thinking in HEI (Higher Education Institutions) and VET (Vocational Training) Education**, and the identification of **new approaches to teaching/learning**. The target group of the D-Think project are educators/trainers who want to rethink the education system and the current teaching/learning methodologies. As a result, the partnership expects HEI's and VET providers to prepare people to respond better to the challenges of the labour market, and so be able to stimulate the growth of flexible and innovative businesses in the future.

Research Report D-Think

Katja Tschimmel, Joana Santos, Dirk Loyens, Alexandre Jacinto,
Rute Monteiro, Mariana Valente



Research Report D-Think

Research Report D-Think

Design Thinking Applied to Education and Training
ERASMUS +
KA2 Strategic Partnerships

Research Report (print version)
October 2015

Project title

Design Thinking Applied to Education and Training

Project Acronym

D-Think

Program

ERASMUS+
KA2 Strategic Partnerships

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European partners of the project

Advancis Business Services (Portugal), Vaasan Ammattikorkeakoulu VAMK Ltd. University of Applied Sciences (Finland), ISTUD Business School (Italy), Akademia Humanistyczno-Ekonomiczna w Lodzi (Poland), Venture Hub (Spain) and EFMD - European Foundation for Management Development (Belgium).



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Executive Summary

Executive Summary

Many academic and governmental organisations call attention to the need for urgent change of curricula and learning methods demanded by continual social transformation and an increasingly technological world. Transversal skills such as the ability to think creatively and critically, take initiative, and work collaboratively for common goals, are essential to guarantee a qualified and entrepreneurial workforce in Europe. The D-Think research project emerged in this educational context, starting in September 2014.

This Research Report is the result of the first phase of the D-Think project, the research about Design Thinking and its application in Education and Training, providing a baseline for the next stages of the project: the creation of the D-Think toolkit and a D-Think m-learning course, both in development and testing until August 2017.

Based on a Constructivist Design Research, the research process itself was structured on a Design Thinking model, the Evolution 6² model.

The main objective of this research report is the clarification of the role of Design Thinking in HEI and VET Education, and the identification of new approaches to teaching/learning which can be useful for the D-Think toolkit for Educators and the m-learning course. The target group of the D-Think project are educators/trainers who want to rethink the education system and teaching/learning methodologies.

The research group came to the **conclusion** that Design Thinking is seen today as a method and a process for investigating open and ill-defined problems, acquiring and analysing information, identifying opportunities for innovation, deepening empathy, experimenting with new perspectives and visualising new concepts. Design Thinking is essentially human-centred, multidisciplinary and collaborative, optimistic and experimental. Its thinking style is characterised by dualistic reasoning, creative thinking, playfulness, reframing and a holistic view. For these reasons it is suitable for application in HEI and VET Education.

Since Heutagogy was identified as the emerging contemporary education style, it served as a **conceptual guide** to this research. In Heutagogy the learner is seen as highly autonomous, self-determined and focused on the development of his learning capacity and capability. Other important trends in HEI and VET teaching and learning methodologies are blended learning, mobile learnings, MOOCs, e-learning, flipped-classroom, problem-based learning and game-based learning. Interviews done with HEI educators and VET trainers showed that most of them are neither familiar with these emerging educational trends nor with Design Thinking, but that they feel the urgency of a change in education and training. Educators do not have a formal design education and are not trained in the creative development of learning programs. Therefore a Design Thinking model with its emphases on empathy, creativity and a human centred approach could be a valuable aid in doing just that. It would provide an educator with the necessary guidelines and support to develop strategies and programs with the goal of improving learning competences and capabilities.

An Educator in the paradigm of Heutagogy is characterised by a human-driven, abductive and problem-based teaching approach and a principally collaborative learning format with different social forms, where mistakes are a part of the process. To develop an entrepreneurial mindset, educators are rather facilitators or coaches in the knowledge creation processes, instead of being knowledge providers as is the traditional teacher. Because of its human-centredness and its multidisciplinary, collaborative and experimental approach, Design Thinking offers an enormous potential to improve the current educational system.

This report is for the following audience:

Firstly for the European partners of the D-Think project, as the report is the base for the development of the D-Think toolkit and m-learning course;

Academics working in the field of educational innovation;

Researchers and practitioners of the Design Thinking community, interested in DT applied in a research process;

Policy makers in Education.

TOP 10

Design Thinking
Principles for Innovation
in HEI & VET Education

1 EVOLUTION
double loop learning,
iteration

**2 DUALISTIC
REASONING**
intuitive and methodical,
rational and emotional,
divergent and convergent

3 COLLABORATION
sharing knowledge,
multi and interdisciplinarity

4 CREATIVE THINKING
thinking in variety and
future possibilities,
thinking outside the box,
against stereotypes

5 EMPATHY
human centred approach,
understanding people's
needs

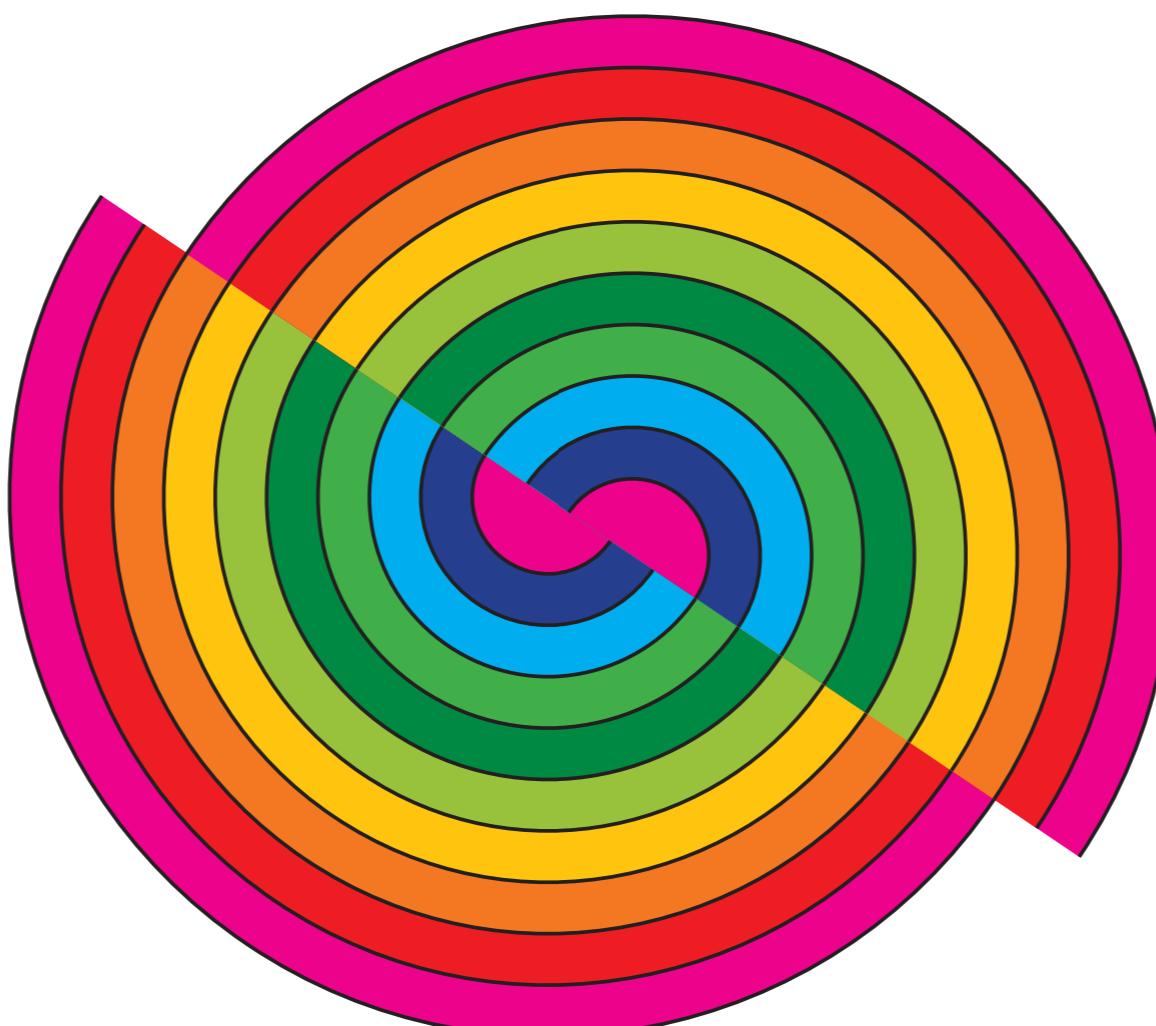
6 VISUAL THINKING
sketching and mapping,
visual boards

7 PROTOTYPING
early materialisation,
early testing and
improving

8 PLAYFULNESS
experimentation,
failure is a part of
the process

9 HOLISTIC APPROACH
connection between
ideas, getting the big
picture

10 MOTIVATION
optimism and dedication,
positive attitude to
novelty and innovation



Contents

chapter 1			
Introduction to the Research Project	12		
chapter 2			
Research Methodology	16		
The foundation			
The Design Thinking model			
The design of templates, matrices, maps and boards			
chapter 3			
Research Process	24		
Introduction			
Emergence Phase			
Acquiring and analysing information, Identification of opportunities			
Empathy Phase			
Knowing better the context and Deepening empathy			
Experimentation Phase			
Generating ideas for the Research Report and for the Learning Toolkit			
Elaboration Phase			
Visualising and prototyping the Research Report			
Exposition Phase			
Communicating the Research Results to the target group			
Extension Phase			
Supporting the development of the Toolkit and m-Learning Course			
chapter 4			
The Design Thinking Concept			54
The origin			
Design Thinking as a method for innovation			
The main characteristics of Design Thinking			
The Design Thinking process models			
chapter 5			
Design Thinking applied in HEI and VET Education			64
Design Thinking in HEI Education			
Trends in Entrepreneurship Education and Training			
Design Thinking in Training and VET Education			
The future of Design Thinking in Education			
chapter 6			
Conclusions of the Research Phase			70
chapter 7			
Bibliography List			76

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O

Introduction to the Research Project

Introduction to the Research Project

As early as 2009, the EU Forum for University Business dialogue called attention to the need for urgent change of curricula and learning methods, as the competitiveness of economies is increasingly dependent on the availability of a qualified and entrepreneurial workforce. More recently, in its publication Rethinking Education (2015), the United Nations Educational, Scientific and Cultural Organisation (UNESCO) points out that we need a new kind of education for a century characterised by continual social transformation. According to the UNESCO report, education should move beyond literacy and numeracy, to focus on learning environments and on new approaches to learning for an improvement of social, economic and environmental conditions. This humanistic vision of education as an essential common good, demands the development of transversal skills such as the ability to think creatively and critically, take initiative, and work collaboratively for common goals. Many recent publications by academics, practitioners and even government organisations, claim that design thinking has the power to stimulate these social competences and to drive innovation in organisations, social institutions and education. Design Thinking (DT) refers to the methods and processes for investigating ill-defined and wicked problems, looking for new perspectives and solutions. DT is founded on the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyse and match solutions to the context.

In an increasingly complex and technological world, above all in education, new learning methods have to be enhanced, as the profile of learners has changed a lot. Digital technologies and the internet have diminished the relevance of the classroom and transformed the teaching/ learning experience. These changes challenge the traditional pedagogical paradigm.

It is in this current methodological and educational context, that the D-Think research project emerged in September 2014, closing in August 2017. During those 3 years, the European partners involved in the project, worked on the following outcomes:

1. Research Report

about Design Thinking and its application in Education and Training;

2. Toolkit

which facilitates the learning of Design Thinking in Higher Education Institutions (HEIs) and Vocational Education Training (VET);

3. m-Learning Course

which permits HEI and VET educators to learn with a digital support the DT methodology.

This report is the result of the first phase of the D-Think project, the research which gives the foundation for the D-Think toolkit and the D-Think m-learning course. The realisation of the research was the responsibility of the Portuguese partner ESAD (College of Art and Design). Forming the ESAD team were: Joana Santos, Alexandre Jacinto, Dirk Loyens, Rute Monteiro, Mariana Valen a, Rute Carvalho and Katja Tschimmel, who coordinated the research process and the elaboration of this report. The legal representative manager of the team was Jos  Sim es, the director of ESAD.

The research work was characterised by regular weekly meetings (November 2014 - May 2015), in which the team travelled through the Design Thinking process itself by applying several DT techniques. In between the meetings, each researcher and designer realised several process tasks. The European partners of the D-Think project participated actively in several phases of the research process. They are: Advancis Business Services (Portugal), Vaasan Ammattikorkeakoulu VAMK Ltd, University of Applied Sciences (Finland), ISTUD Business School (Italy), Akademia Humanistyczno-Ekonomiczna wŁodzi (Poland), Venture Hub (Spain) and EFMD | European Foundation for Management Development (Belgium).

The focus of this research project is on using Design Thinking to redesign education and to develop educational tools. The use of the D-Think toolkit and m-learning course will also contribute to a change in the educator's mindset. It is not our purpose to teach educators how to teach Design Thinking to their students.

The authors of the D-Think project would like to thank Prof. Jose D'Alessandro (ISTUD Business School) and Prof. Ricardo Morais (Catholic University of Porto) for their scientific revision of this report and for their constructive and valuable comments.

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Research Methodology

Research Methodology

The foundation

The research methodology is based on Constructive Design Research as described in the book *Design Research Through Practice* (Koskinen, Zimmerman, Binder, Redström, Wensveen, 2011). Koskinen et al. found their approach on the concept of 'Second Modernity' by Andrea Branzi, who identifies new opportunities for the discipline of Design based on emerging social trends starting in the early 1980s. These new opportunities can be summarised as:

- ② The change from an industrial and consumer focus in design, to a technology and human centred focus.
- ② The evolution of design from product and graphic design to service, system and business model design.
- ② The movement of design methodology from the rational and analytical paradigm to the paradigm of emergence, characterised by a holistic and pluralistic approach (in Koskinen et al., 2011: 10).

As the rationalistic design movement of the 1970s failed, designers and design researchers turned to the behavioural and the social sciences, where user-centred design, ethnographic research, emphatic methods, multidisciplinary collaboration and a systemic approach are crucial (Koskinen et al., 2011). From the 1990s on, novel 'generative' research methods also put design practice at the core of a research process. These practice-oriented methodologies include experience prototyping, game-based proceedings, visual tools such as mood boards, storyboards and personas. These techniques are today an essential part of the

Design Thinking process. Since this novel Constructive Design Research process is essentially multidisciplinary, not only designers, but also many different people from other disciplines are regularly involved in the design process.

Summarised, Constructive Design Research can be characterised as:

- ② not based on natural sciences (facts), but on humanistic and interpretative social science;
- ② exploring the imagined world inspired by experiencing, interacting, playing, simulating, etc.;
- ② producing ways to understand how people interact with the artificial world.

Constructive Design Research creates knowledge about:

- ② the design process and its techniques;
- ② how to apply these techniques in design practice and in other innovation contexts (education);
- ② ways to justify methodological choices and the understanding of these choices.

It is precisely because of those characteristics that a Constructive Design Research approach has been chosen as the methodological foundation the D-Think research process. The following diagram explains in a visual way the theoretical approach of the research methodology.

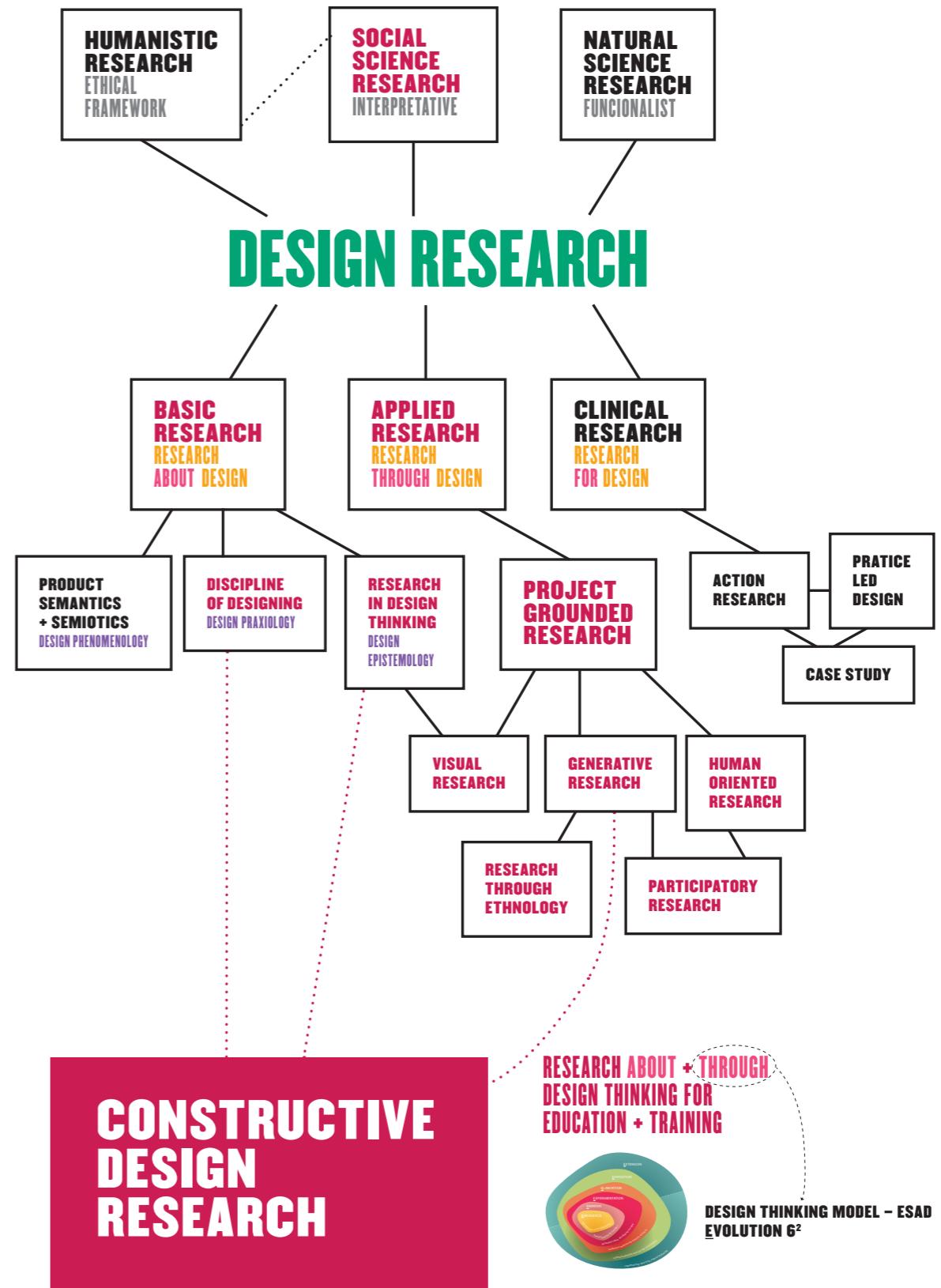


fig. 2 Diagram of the Research Methodology

The Design Thinking model

As Constructive Design Research is intimately connected with design practice and applied research, the research phase itself used a Design Thinking methodology. Design Thinking includes quantitative and qualitative, primary and secondary research methods, connected with visual thinking and sense-making tools in a similar way as Design Research does. Furthermore, the research process itself is structured on the Design Thinking phases, and several DT tools are applied and tested in the research process. This approach has an experiential character, and is seen as a Case Study for Design Thinking applied in Research.

The DT model to be used for the research part of this project was the Evolution 6² model, developed by the coordinating head researcher, Katja Tschimmel, for ESAD and the SME Na'Mente in 2012. It has been licensed since 2015 under Creative Commons Attribution 4.0 International License in the version 'by-sa' (to view a copy of this license, visit <http://creativecommons.org/licenses/by-sa/4.0/>) with the name Mind-shake Design Thinking Model - Evolution 6².

The application of the Design Thinking model Evolution 6² in the research process itself has an experiential character, and is seen as a Case Study for Design Thinking applied in Research.

The model being composed not only by 6 phases but also by 36 DT tools, the maximum of the techniques and associated methods were applied in the research process. Beside many of the visual tools such as matrix, visual boards, maps, etc., primary research methods were used in the Emergence and Empathy phase, such as observation tools, and interviews (human centred approach based on ethnography). Secondary methods included research on literature, data analysis and assessment on: (i) the evolution of the Design Thinking concept; (ii) the Design Thinking potential as a learning tool (literature and visual research); (iii) Case Studies on the use of Design Thinking as a learning tool in different contexts: higher education areas and vocational training; (iv) the emergence of new learning methods linked to DT, such as problem based learning or game based learning.

The model is called **Evolution 6²** for the following reasons:

Evolution because the creative process is an evolutionary and iterative process in which a lot of individuals and situations are interacting. The graphical solution illustrates that each E-phase of the model is connected with the other phases in iterative loops. The original graphical representation was developed by the Portuguese Design Atelier Nunes and Pã, but was recently redesigned by Irena Übler.

E6 because in English as well as in Portuguese, the name of every stage of this six phased model starts with an ‘E’: Emergence, Empathy, Experimentation, Elaboration, Exposition and Extension. And since there are also moments of Exploration (divergence) and Evaluation (convergence) in every phase of the model, the model is called E6².

The research group decided to adopt the Evolution 6² model, to verify if it can also be applied in research, assuming this project as a Case Study. The model has been applied and validated in several design projects before: in the redesign of the Multimedia Course at ESAD, in classes and projects of the Post Graduation Course in Design Thinking at ESAD (case studies for Apgei and Amorim Cork Ventures), and in Training and Coaching sessions for Portuguese companies (Roche, Moretextile, NOS, etc.) realised by the SME Na'Mente.

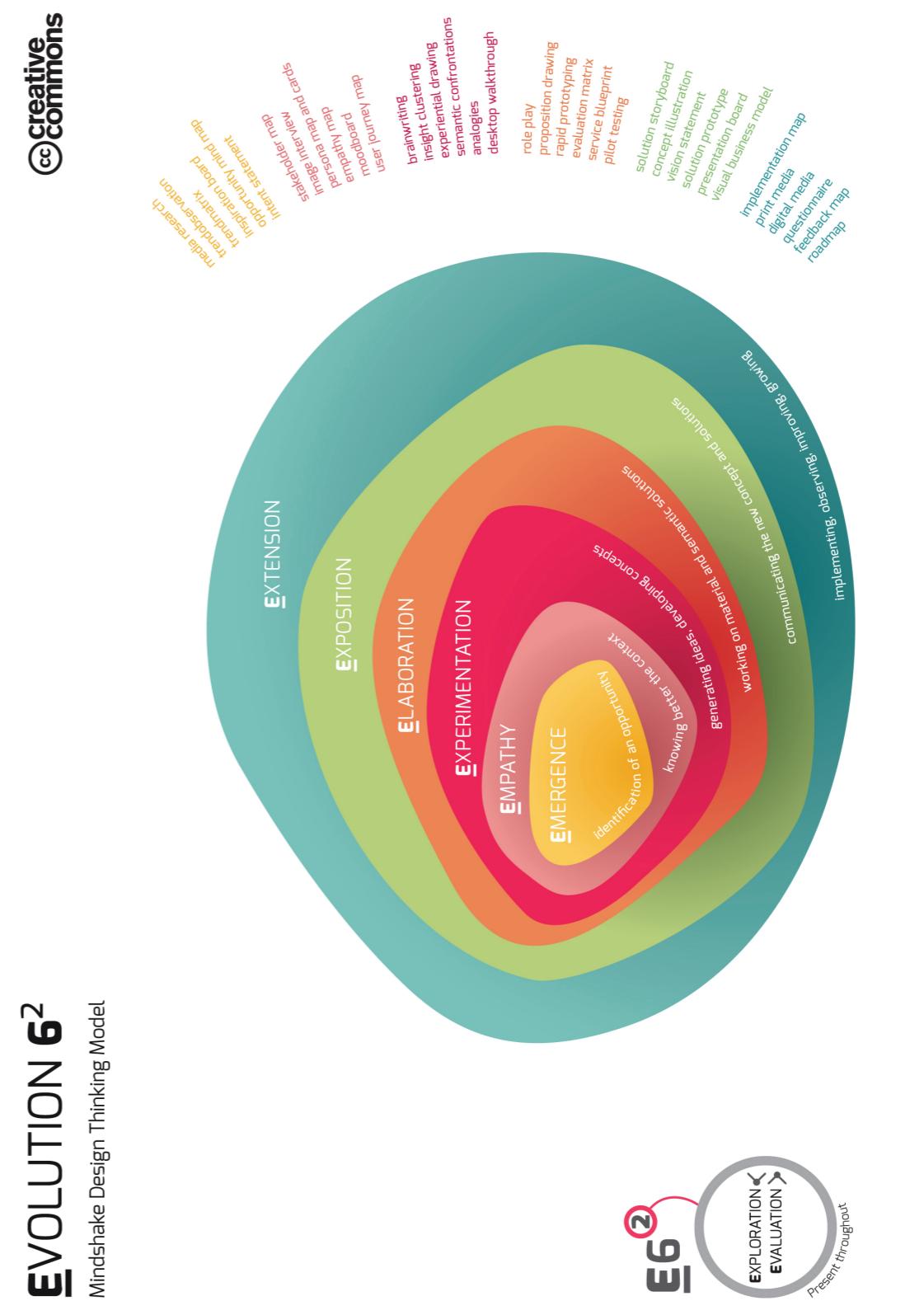


fig.3 The Mindshake Design Thinking model Evolution 6²

Research Report

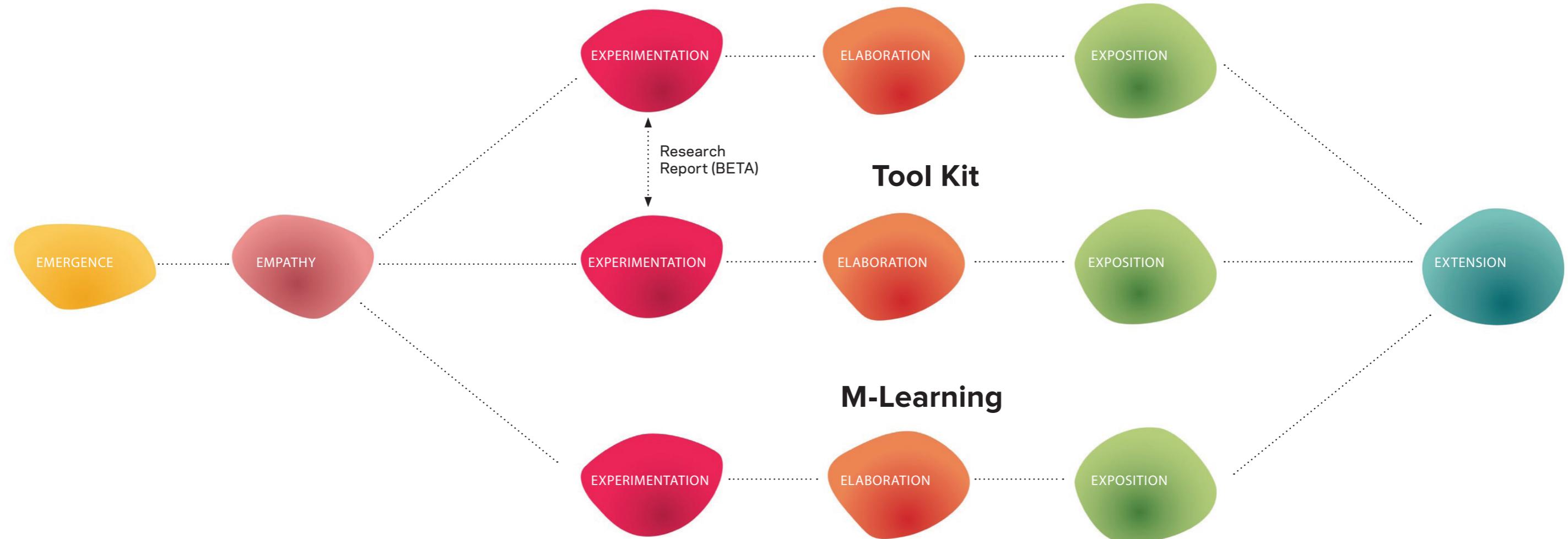


fig. 4 Diagram of the Research Process during the 3 years of the D-Think Project

The design of templates, matrices, maps and boards

To streamline collaboration within the research group at ESAD, and between the local research group and the European partners, several DT templates were elaborated. These templates will be presented in the chapters describing the different E-phases of this research project:

- ⇒ a template for the organisation and visualisation of secondary research (Media Research Card - Emergence phase) [fig. 9]
- ⇒ a template for systematising the identified trends of teaching and learning methods and of DT toolkits (Trend matrix - Emergence phase) [fig. 10, 11]
- ⇒ a template for the interviews with images (Interview - Empathy phase) [fig. 16]
- ⇒ a Persona template (Personas – Empathy phase) [fig. 22]

To visualise the field research results and the results of secondary research, several **maps, diagrams and boards** were elaborated:

- ⇒ the Research Methodology diagram [fig. 2]
- ⇒ the D-Think skill diagram [fig. 42]
- ⇒ an Opportunity Mind Map [fig. 14]
- ⇒ a Stakeholder Map [fig. 15]
- ⇒ the Inspiration Board [fig. 13] and the Mood Board [fig. 24]
- ⇒ the first draft of the DT Toolkit Matrix [fig. 28]
- ⇒ a Photo-Storyboard about the whole research process [fig. 32]
- ⇒ and finally the diagram, which explains visually the research process of all involved European partners of the D-Think project [fig. 4]

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Research Process

Research Process

Introduction

Understanding if similar work has been done in the area of ‘design thinking’ and ‘education/training’ is essential for perceiving the importance and the relevance of the ongoing study. Furthermore, it is paramount to consult pioneering research that can provide theoretical support and contribute with insightful thoughts on the development and management of this research project. Media Research was started with a review of scientific text sources and a scan of popular media like websites, social media, specialist magazines and other media. The objective was to look for insights finding new perspectives and directions for the research, and work on building a credible foundation. In the first meeting between all partners of the project the following set of four fundamental **research questions** were discussed and accepted:

- ⦿ Why is DT important to education?
- ⦿ How is DT transferable to education?
- ⦿ How can DT improve the learning process?
- ⦿ Which kind of DT tools are appropriate in teaching and learning processes?

The **hypotheses** which was the origin of this research question is:

Design Thinking is a transversal learning methodology which improves learning experiences and professional training.



fig. 5 Brainwriting and Clustering on the research questions of the project

Emergence phase

Acquiring and analysing information

A systematic literary search was conducted with the objective of quantifying relevant literature about the subject in study. The following bibliographic database were used in this study: Research Gate, Academia, Scopus, ERIC (Institute of Education Sciences), Science Direct, EBSCO, B-on and Web of Science. Additionally a general search on the internet was conducted using the Google Scholar search engine. This research was conducted in March 2015.

The following boolean combination of keywords was used for this systematic literature search: “design thinking” AND education OR training. The bibliographic search was limited to the title of a peer reviewed journal article, book chapter or conference presentation paper.

The table below [fig. 6] presents selected results obtained for each database, considering the specific theme of the publications. To conclude this, it was necessary to analyse all abstracts of the literature gathered in each database search and select only those in accordance with the goal of this research project.

DATA	BASE NUMBER OF RESULTS - HITS FOR EACH THEME		
	Design Thinking AND Education		Design Thinking AND Training
	Design Thinking IN Education	Design Thinking Education	
SCOPUS	8	14	1
web of science	0	4	4
Science Direct	1	2	0
Google Scholar	10	66	0
Academia	3	1	0
Research Gate	18	9	0
ERIC (Institute of Education Sciences)	2	5	0
EBSCO	6	4	0
B-on	4	3	0
TOTAL	88	108	5

fig. 6 Table of literature research for each database

After eliminating the repeated results, the number of bibliographic references found for the main theme of the research was as presented in the table below

[fig. 7]. For the specific theme of this study, Design Thinking in Education, 39 peer reviewed publications were found.

THEME OF STUDY	NUMBER OF REFERENCES
DT in Education or Training	39
DT Education or Design Education or DT Programmes	21

fig. 7 Table of bibliographic references for DT in Education and Training

An additional research, limited to the Google Scholar database, was done with the following conditional keywords: “design thinking” AND “teaching” OR “learning” OR “heutagogy”. After analysing the abstracts, the results of this search process were divided in two groups [fig. 8].

THEME OF STUDY	NUMBER OF REFERENCES
DT applied in Teaching or Learning or Heutagogy	23
Teaching or Learning DT	24

fig. 8 Table of bibliographic references for DT - Teaching and Learning

All relevant search results were compiled in a list containing the bibliographic reference in APA style, and for those publications relevant for this study the full abstracts were also included in the list. This full list of results can be consulted in the following link: <http://www.esad.pt/documents/144/attachments-d-think-report.pdf>.

Media Research

Researcher's name	Katja Tschimmel
Institution	ESAD Matosinhos
Date	October 2014
Bibliographical reference (according APA Norm)	Koekinen, I., Zimmerman, J., Binder, T., Redström, J., Wensveen, S. (2011). Design Research Through Practice. MA: Elsevier - Morgan Kaufman. ISBN 978-0-12-386560-2.
Information about the author(s) Quantity of author(s)	5 authors
Origin (countries)	North European Countries (Finland, Denmark, Sweden, The Netherlands, England)
Knowledge background (disciplines)	Multidisciplinary - Culture, Art and Design, Cognitive Psychology, Social Science, Engineering, Education.
Institutional background (university, research institutions, etc.)	Universities & Design Firms.
Associated institutions (names)	Academy of Finland, Aarhus School of Architecture, Aalborg University School of Art and Design, Imagination Institute Lancaster, Lab4Living, etc.
Information about the source	Format: <input checked="" type="radio"/> Book <input type="radio"/> Magazine Article <input type="radio"/> Scientific Paper <input type="radio"/> Video <input type="radio"/> Website Other Style: <input checked="" type="radio"/> Scientific <input type="radio"/> Didactical <input type="radio"/> Informative <input type="radio"/> Popular <input type="radio"/> Case Study Other

Media Research

Researcher's name	
Institution	
Date	
Bibliographical reference (according APA Norm)	
Information about the author(s) Quantity of author(s)	
Origin (countries)	
Knowledge background (disciplines)	
Institutional background (university, research institutions, etc.)	
Associated institutions (names)	
Information about the source	Format: <input type="checkbox"/> Book <input type="checkbox"/> Magazine Article <input type="checkbox"/> Scientific Paper <input type="checkbox"/> Video <input type="checkbox"/> Website Other Style: <input type="checkbox"/> Scientific <input type="checkbox"/> Didactical <input type="checkbox"/> Informative <input type="checkbox"/> Popular <input type="checkbox"/> Case Study Other
Identification of related publications	
Contribution to the D-Think Research Short explanation	
Resulting Diagram / Map (link to the image)	
Curiosities / Open question(s)	



D-THINK

Erasmus+

Media Research Cards

Each researcher analysed up to six selected publications (paper, books, toolkits, etc.) with relevance to the present study and elaborated Media Research Cards [fig. 9]. In total thirty-five Media Research Cards were completed.

Media Research Analyses

All Media Research Cards were carefully analysed and a total of six peer reviewed journal articles and research papers were selected as most significant for this research project. All these papers are directly related to the Design Thinking concept and to new learning approaches. However, the elaboration of the Media Research Cards was not limited to peer reviewed articles and book chapters, but considered all relevant publications. Since DT toolkits, books and research reports are not peer reviewed but might be of equal importance for this study, a separate selection was made including a further selection of five publications considered essential for the development of the DT Toolkit.

The selected peer reviewed papers

Cochrane, T., Antonczak, L., Keegan, H., & Narayan, V. (2014). Riding the wave of BYOD: developing a framework for creative pedagogies. *Research In Learning Technology*, 22, 133-46. doi: 10.3402/rlt.v22.24637

This paper was selected for its careful research study of a framework designed for mobile learning programmes and because of important insights about the affordances of mobile devices in creative pedagogies and emerging student learning styles. The authors of this paper have conducted several m-learning courses over the last ten years, contributing with important knowledge to the field of M-Learning. Furthermore, M-learning courses are of particular relevance to the research project since one of the planned outcomes of this project is itself an m-learning course about the use of the DT Toolkit in education and learning.

Dorst, K. (2011). The core of 'design thinking' and its application. *Design Studies*, 32, 521-532.

This paper was selected because the author Kees Dorst had an active part in the original research movement in design thinking in the early 1990s. His

research work was related to the review of the methodological paradigms of design (Dorst 1997). Today he is still researching in that domain, but focused on the transfer of design thinking to other professional fields. In this paper, Dorst explains his perspective on the core of design thinking and what it could bring to practitioners and organisations in other fields. He describes the fundamental reasoning patterns behind design, and then looks at the core design activities of framing and frame creation. In his view, it is the creation of new frames in open and complex problem situations, where design thinking can give a valuable contribution to organisations. In problematic situations organisations often react in a way that requires the least effort and fewest resources, thus setting out in a conventional problem solving manner. Design thinking can help them in the deconstruction of a problem, finding new perspectives or frames from which to approach it. And in this aspect, the paper is a rich contribution to the field of education, particularly in the reframing of education methods.

Hase, S., Kenyon C. (2001). Moving from andragogy to heutagogy: implications for VET. *Proceedings of Research to Reality: Putting VET Research to Work*. Australian Vocational Education and Training Research Association (AVETRA), Adelaide, SA, 28-30 March, AVETRA, Crows Nest, NSW. Published version available in: http://www.avetra.org.au/Conference_Archives/2001/proceedings.shtml

In this paper the authors refer for the first time to Heutagogy as the study of self-determined learning. Heutagogy draws together several ideas from various approaches to learning that emerged from the 1950s until late 1990s. Understanding the future of higher education and training regarding new methodologies is vital to the development of the D-Think project. Heutagogy is seen by many as an essential approach to the development of individual capability. In a rapidly changing world, capable people are more likely to be able to effectively respond to a changing environment and workplace.

fig. 9 Template for the Media Research Card

Kimbell, L. (2009). Beyond design thinking: Design-as-practice and design-in-practice. Centre for Research on Socio-Cultural Change (CRESC). Manchester. Available in <http://www.lucykimbell.com/LucyKimbell/Writing.html>

This paper is a very valuable contribution to the evolution of the concept of design thinking. In the introduction of the paper, Kimbell identifies the reasons why the term DT is confusing. Then she exposes in a very synthetic way the development of the DT concept, from a cognitive style to an intellectual and methodological approach to problem framing and problem solving, considering social and business aspects. This paper was also selected because of the importance of the author who has published several papers about Design Thinking, and more recently *The Service Innovation Handbook* (2014, BIS Publishers).

Scheer, A., Noweski, C., & Meinel, C. (2012). Transforming Constructivist Learning into Action: Design Thinking in Education. Design and Technology Education: An International Journal, V, 17, 3. 8-19. Available in <http://eric.ed.gov/?q=%22Design+thinking+in+Education%22&id=EJ996067>

This paper is an important contribution to this research project because it relates DT to the constructivist perspective of learning, which in itself is also related to Heutagogy, the learning approach which was considered appropriate for this D-Think project. Constructivism offers a good theoretical basis to developing a teaching model in which students can co-determine the learning methods. Constructivist didactics understands learning as a process of self-organisation of knowledge. The educator shouldn't merely produce the knowledge that 'goes into the student's head', but he or she should facilitate processes of automatic and independent development and acquisition of knowledge, and so create the conditions for self-organisation of the learners. In this paper, the authors show how DT offers teachers support towards practice-oriented and holistic modes of constructivist learning in projects. Their case study confirms an improvement of classroom experience, for teachers and students alike, when using DT.

Von Kortzfleisch, H. F. O., Zerwas, D., & Mokanis, I. (2013). Potentials of Entrepreneurial Design Thinking® for Entrepreneurship Education. 4th International Conference on New Horizons in Education, 106(0). 2080-2092. doi:10.1016/j.sbspro.2013.12.237

This paper was selected because of the innovative proposal it introduces: the application of Design Thinking methodology to Entrepreneurship Education. This publication introduces a model for entrepreneurial design thinking® and analyses its potential as a new method for entrepreneurship education in universities.

Important books, articles and reports for the D-Think project (not peer reviewed)

Gaebel, M., Kupriyanova, V., Morais, R., & Colucci, E. (2014). E-learning in European Higher Education Institutions - Results of Mapping Survey 2013. European University Association: EUA Publications.

The relevance of this study to the DT Research is the awareness of e-learning/m-learning as an effective way of innovation in the learning process. According to the study, the main purposes for e-learning's use are cited as being: "the more effective use of classroom time and greater flexibility in learning provision, regardless of whether learners are on or off campus, recent school leavers or adult learners". Also presented are two important structural reflections to be taken into consideration for the elaboration of the toolkit and e M-Learning tool:

1. "(...) e-learning can in many ways help to stimulate and inform institutional discussions and reform – should transfer e-learning from the realm of specialist discussion into a wider European debate on learning and teaching methods in higher education, in which leaders, practitioners and researchers at institutions could all take part." 2. "(...) changes taking place are not only of a technical nature but also social and intellectual."

IDEO (2015). The Field Guide to Human-Centred Design. 1st Edition. Available in <http://www.designkit.org/>

This latest toolkit developed by IDEO can be considered as the logical follow-up to the previous publica-

tion from IDEO: "Human Centered Design Toolkit HCD". While the first version, originally from 2009 but with a revised second edition in 2012, is specifically focused "on base of the pyramid" design for use by NGO's in developing countries, this new toolkit is targeted on anyone who wants to apply a Human Centered Design strategy to a design and development process for a product or a product-service-system. Although it is not specifically built for use in developing countries, NGO's can still use it for this purpose. The design process described in the previous publication was divided into three main phases: Hear - Create - Deliver (hence with the acronym HCD). The design process presented in this new toolkit is also divided into three phases, named: Inspiration - Ideation - Implementation. The general structure is thus very similar to the previous process. However the selection of design tools is more extensive and their logical order is slightly changed. Despite the fact that "Design Thinking" is not once mentioned throughout, this field guide can be considered a bit strange. The sequential organisation and structure of this toolkit and the use of multiple DT tools, makes it easily fit within the design thinking framework. Another publication from IDEO with which this field guide can be compared, is the toolkit "Design Thinking for Educators" (identified below). This design guide is specifically targeted for application in a design challenge in the field of education, be it the design of education spaces or the development of curriculum, processes, tools or systems. Although the process described in this guide is divided into five phases, based on the DT model proposed by Stanford, intent and underlying structure are very similar to the structure of the HCD process proposed in the Field Guide. As a final conclusion it can be stated that this new toolkit: "Field Guide to Human Centered Design", seems to strive for a more effective approach to the HCD process. It is therefore quite versatile and can thus be used for any design challenge anywhere, including education.

Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2011). Design Research Through Practice. MA: Elsevier - Morgan Kaufman.

The book gives an important contribution to bridging the gap between Design Research and Design Practice, providing multidisciplinary examples, and illustrating how research could be applied in design practice. The approach of Constructive Research in Design Re-

search is important to the foundation of the Research Methodology of D-Think. It supports the Methodology "Research about and through Design Thinking".

Riverdale, & IDEO (2012). Design Thinking for Educators. 2nd Edition. Available in <http://www.designthinkingforeducators.com/toolkit/>

At present (May 2015), this toolkit developed by IDEO is the only DT toolkit specially conceived for educators. It is a step-by-step guide that offers many ways of designing new solutions for classrooms, schools and communities. The target audience are educators who want to improve their methods and results. There are a lot of problems in education today both in K12 and in HEI education, and this toolkit is positioned as an opportunity to design new possibilities in harmony with the needs of educators and students alike. These needs are evolving as rapidly as the technologies that compete for attention. Furthermore, the challenges facing educators are very complex and vary from school to school. Teachers know their students and their school better than others, and they require new perspectives, new tools and new approaches. Design Thinking could be one of these approaches. In 2007, Riverdale began exploring how Design Thinking could be used by their faculty and students with the help from IDEO. The outcome of this collaboration was the Design Thinking toolkit for Educators.

Zupan, B., Nabergoj, A.S., Stritar, R., & Drnovsek, M. (2014). Action-based learning for millennials: Using design thinking to improve entrepreneurship education. In E. Doyle, P. Buckley, & C. Carroll, (Eds.). Innovative Business School Teaching: Engaging the Millennial Generation. Routledge.

In this article, the authors present an approach to teaching entrepreneurship in HEI using the Design Thinking methodology. The authors consider Design Thinking as a valuable teaching tool and present a case study of an entrepreneurship course where this methodology was applied with success. Students, scholars and companies involved in the course gave positive feedback on the experience.

Trend Observation and Matrix

Identification of trends in learning methods

Analysing the results of the media research and the systematic literature search, in this first part of the research were given a wealth of information about what is changing in the field of education for HEI's. Important information and insights were gathered about topics of ongoing research; about the influence of a constructivist view on education and the importance for the development of active learning strategies; about the results and application of novel methods in HEI; about the supporting role of technology in the shaping as well as in the success of active learning and teaching methods, and much more.

Organisation and visualisation of trends

All this information had to be summarised in a clear and visual way in order to support the further analysis and development of the toolkit during this research project. And so, a standard DT tool, the Trendmatrix (Kumar, 2013), was used. A trendmatrix serves as a summary of continuing change and gives a structured visualisation of the ongoing evolution in the project field. As such, the D-Think Trend Matrix provides a framework for the classification of current, former and emerging tendencies in HEI education and education strategy. It further informs and maps, over time, the innovation, transformation and modification of the most important parameters of teaching and learning methods. [fig. 10]

Creative Process Models and DT-Toolkits

A similar approach was used to evaluate trends in the development of creative process models and descriptive models for the DT process. Insights from a DT-model matrix and the application of the trendmatrix yields an interesting overview of how even for this particular topic, interesting direct relations can be observed between the construction of knowledge about DT, the descriptive model of the DT process and how this information is graphically treated and presented to the community. [fig. 11, 12]

Inspiration Board

The Inspiration Board is a popular tool to visualise ideas and inspirations from individuals or groups alike. This tool can be used in many contexts: in companies, classes, coaching sessions, events and much more. It's a way to transmit thoughts and perceptions through images with the goal of discovering new opportunities and challenges. The use of an inspiration board is fun, and stimulates creativity and visual thinking. It is risk free and stress free, and it allows each person to create a different concept in his or her mind without criticism and judgment from the others.

[fig. 13]

Trendmatrix

Classification of Trends of Teaching and Learning Methods

	formerly	currently	emerging
educational style	PEDAGOGY: discipline-based education, teacher centric	ANDRAGOGY: interdisciplinary education, project based teaching and learning, curriculum centric	HEUTAGOGY: interdisciplinary and problembased education, learner centric, autoregulative, design-based
learning style	individual work, dependent learning, learning by memorising, labour experiences	group work, independent learning, learning by doing, participative and collaborative,	combination of individual and group work, autonomy, experiential learning (active experimentation + reflective observation), real life experiences, competitive learning (by games), meta-cognitive, learning analytics
students role	passive participant	active participant, individual and critical	peer support, self-determined, team effort, control of own learning, quantified self
teaching style	frontal and expository style, homogenised teaching	roundtable communication style, student centred, differentiation in class	variable teaching styles, co-determination of teaching/learning contents
teachers role	Teacher = Master, teacher evaluates	Teacher = Tutor/Pilot, mixed evaluation (teacher+ group+self-evaluation)	Teacher = Facilitator, maximum of self-evaluation
training offers	classroom training, seminar, conference	in real context training, outside company training, personalised training courses	short training courses, co-working courses, maker space, combination of contents, informal, unscheduled
learning ambience	in classroom/auditorium, hierachic classification of contents, rigid timetable	in flexible rooms, tables in group position, partial classification of contents, adaptive and flexible timetable	without walls, different social forms, bootcamps, pitch days, learner centred timetable
technology (web, mobile, etc.)	using computers in classroom	e-learning, online courses, b-learning,	m-learning, virtual assistant, MOOCs (massiveopenonlinecourses - http://moocs.com)

fig. 10 Trendmatrix - Classification of Trends of Teaching and Learning Methods

Trendmatrix

Classification of Trends of Creative Process Models and DT-Toolkits

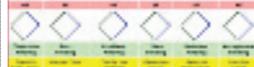
	formerly	currently	emerging
presentation of PHASES	Linear, 4 - 7	Organic, 3 - 6	Iterative, 5
colour codes	Neutral	Rainbow	Unicolour, Yellow
background	CPS, Industrial Design Methodology	(Service) Design Thinking	Design Thinking for Educators
authors	CPS: Osborn, Parnes, Puccio	IDEO, British Council, d.school, ESAD, etc.	IDEO/Stanford
elements	process model, description of techniques	book or booklet with the process model and tools, Card Set with tool description, tool icons	mobile application
icons			

fig. 11 Trendmatrix - Classification of Trends of Creative Process Models

DT - Model Phases

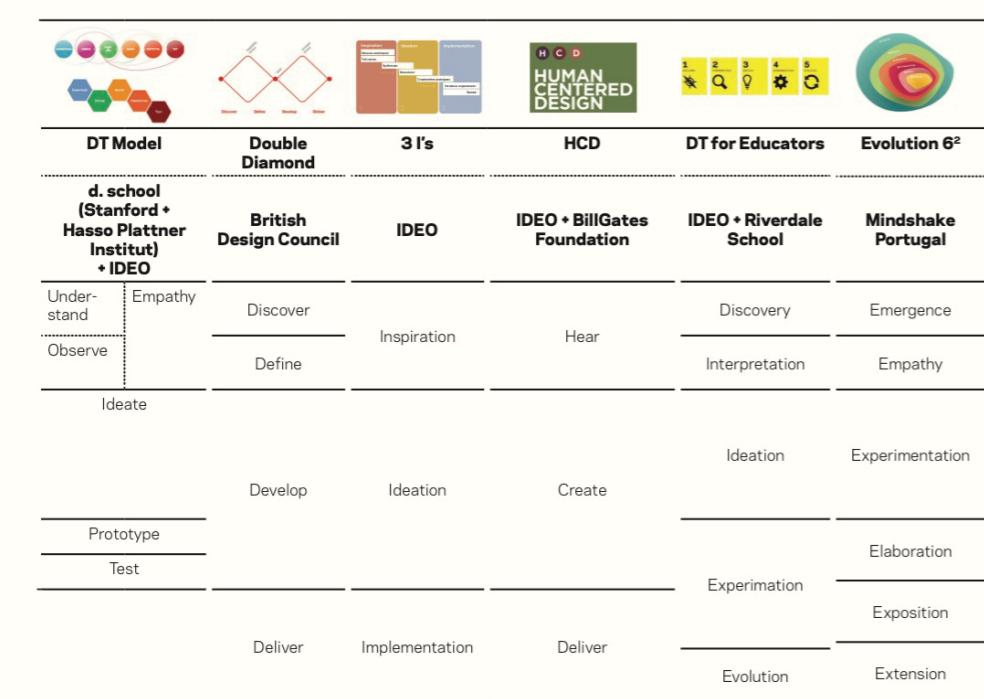


fig. 12 Comparison of the phases of different DT Models



fig. 13 Inspiration Board

Emergence phase

Identification of opportunities

Opportunity Mind Map

With the increasing amount of information gathered during the secondary research phase, it became obvious that a visualisation tool would be most important for the team to have a holistic overview of all these new concepts and insights and how they relate to each other. Stimulated by the Inspiration Board, an Opportunity Mind Map was constructed to explore and organise the new knowledge and insights which were gathered up till then.



fig. 14 Opportunity Mind Map

The main theme of the project, Design Thinking applied to Education and Training, is located at the centre of the mind map. Two main branches were set on a horizontal axis: one for HEI Education and another one for VET Education/Training. The layout started by dividing the data into several sub branches and sections based on the main categories identified during the ongoing research, such as: emerging teaching trends, future teaching trends, game-based learning, stakeholders of HEI and training, and many more. On top a DT branch was set that would evolve into tree structure with all the main methods and tools of DT. This way it was possible to frame DT as a mindset to problem solving. This was most important since it was necessary to visualise the relationship between DT, education process models, learning methods and heutagogy.

The idea of learner-centred education, Andragogy, is recognised as the main goal of HEI institutions, but Heutagogy as an evolution of Andragogy, was identified as the emerging education style, as has been shown in the Trendmatrix above. Therefore a major branch of the Mind Map was set as the future of HEI education. As such, it became clear that the core "opportunity" for the development of the tool kit would be the vertical axis illustrating the strong relationship that can be established between by DT and Heutagogy. This relationship sets the focus of the DT Toolkit as a support for teachers and trainers of educational and training institutions in the preparation of life-long learners who are capable of adapting to the fast and constant changes in the demanding needs of the workplace.

Glossary of the concepts in the Opportunity Mind Map

Andragogy is an educational theory for adult teaching, characterised by learner control and self-responsibility in learning. The role of the educator is that of a tutor or facilitator to support the learner to become more self-directed in his learning.

Heutagogy is based on the methodological approach of self-determined learning where learners are highly autonomous, self-determined and focused on the development of their learner capacity and capability.

eLearning is the use of information and communication technology as a platform for teaching and learning activities. Although it first started off in the 90s, as a distance learning tool, it has recently been used in the proper classroom as well.

Mobile Learning builds upon the concept of E-Learning and can be defined as the use of mobile technologies, together with wireless and mobile networks, to extend, allow and facilitate teaching and learning, at any time and anywhere. People can use mobile devices to get instant access to educational resources, create and share content, and connect with others, both inside and outside the classroom.

Blended Learning is any programme which combines face-to-face instruction with any form or use of online resources to provide the student with a more personalised learning experience. Although online learning can be at other locations than the classroom, most applications of blended learning are done in the proper classroom or school building, using models such as Lab Rotation, where groups of students switch between individual online learning and face-to-face discussion in the classroom, or the Flex model, in which students engage online in the classroom, but always under the supervision of a teacher who is physically present.

MOOC stands for Massive Open Online Courses and, although successfully in development since 2008, has grown rapidly since 2012. The main purpose of a MOOC is to improve the learning

experience and to provide more learning opportunities. MOOCs are free online courses, accessible to everyone with no formal entry requirements. Institutions that provide MOOCs don't award credits, only a participatory certificate, although this is to change in the near future.

Flipped Classroom is a learning and teaching approach where passive learning activities are removed from the classroom, and precious class time is spent on active and collaborative learning. More personalised guidance and interaction with the students allows for differentiated learning where students engage directly with material and review content at their own pace.

Problem Based Learning (PBL) is an active learning method where students work in small collaborative groups to resolve complex, realistic problems under the guidance or coaching of the teacher. The students' learning occurs in the context of solving an authentic problem and all learning activities are related to a larger task.

Game Based Learning (GBL) is a strategy where a game structure is applied with well-defined learning outcomes and with the goal of enhancing the learning experience and the motivation of the student. Competition, intrinsic motivation and immediate rewards encourage active learning, self-reliance and self-determination. Thought processes and subject matter are balanced with game play and as a result, the student works towards a goal, can choose his actions and experiences the consequences.

Maker Spaces are learning environments where active learning is at the centre of the learning process. The main objective of a maker space is teaching problem solving skills through a project-driven process of learn-by-doing. This learning process is self-directed, informal and unscheduled.

Intent Statement

An Intent Statement, according to Kumar (2013: 48) is "stating an initial innovation intent based on an identified opportunity". After analysing the collective Opportunity Mind Map, the research group got a new sense of the main focus of the research, which contributed also to an extension of the initial research questions. The Intent Statement technique builds on the understanding that a clear view of the further research is at some point necessary. Intent Statement is a tool which offers the opportunity to reframe the original goals of a project. Using the structure offered by Kumar, the research group came to the following understanding:

Intent Statement *

Principal Problem

Research questions.

Intention

Elaboration of a research report, which offers orientation and important insights to the development of a DT toolkit and a website for educators and trainers, based on the Evolution 6² model.

Opportunities

Better understand the potential of DT for education and society.

Contextualise DT between other emerging learning methods.

Create a theoretical foundation for a specialised DT toolkit for European HEI and VET educators.

Test the Evolution 6² DT model in a research project.

New Value

Insights for the development of a DT toolkit especially for educators and trainers, based on the educational concept 'Heutagogy' and on emerging trends of learning methods.

Public

All European partners of the D-Think project, and additionally, everybody interested in the D-Think research process.

* It is important to emphasise that this Intent Statement is only for the elaboration of the Research Report, not for the further D-Think project (toolkit development and m-learning course).

Redefinition of the research questions of the D-Think project

As a consequence of all secondary and media research done up to this point, and after the realisation of the Intent Statement, we completed the initial research questions in the following way, being the new questions marked in bold:

- ➲ **What is DT and why it is important to HEI and VET education?**
- ➲ **What is the level of knowledge in education about DT?**
- ➲ How is DT transferable to education?
- ➲ How can DT improve the learning process?
- ➲ Which kind of DT tools are appropriate in teaching and learning processes?
- ➲ **How can the new DT toolkit help educators to learn how to improve the learning competences and capabilities of their learners?**
- ➲ **Is the Evolution 6² model appropriate to be applied in our research process/learning process?**

Conclusion of the Emergence Phase

The most important conclusion which can be drawn from this phase is the strategic shift in HEI education from Pedagogy to Andragogy, and just lately from Andragogy to what has been called "Heutagogy". The driving force behind the transformation from Pedagogy to Andragogy is rooted on the protagonism of the actor in the mechanism of knowledge transfer in the process of teaching and learning. Focus is no longer on the teacher but converges on the learner who has to take an active role in the successful conclusion of his own educational development. However, expansion of the body of knowledge and the evolution of methods for sharing this information points to yet another emerging progression in educational strategy and style. General access to this wealth of knowledge and information, together with the importance which has been given to technology in the process of learning and teaching made it clear that the process of learning can no longer be confined. Teaching and learning are no longer time and place restricted. Learning and

teaching are life-long ventures no longer confined to universities or schools. Learning and teaching are no longer separate endeavours, each learner is also his or her peers' teacher. Both teachers and learners share the same information and assessment is a continuous self-regulated process. It is exactly in this new context and learning paradigm, that Design Thinking can play an important role. If we compare the Design Thinking principles with the new role of educators in the teaching/learning approach of Heutagogy, we can find many parallelisms, as the characteristics of the DT educator in figure 41 showed us. Design Thinking is based on a human-centred approach, which expresses itself in the collaborative way designers work and in participatory methods of co-creation. The product/service-user in DT can be seen as a 'partner' in the creative process. As the designer does, in the new learning approach of Heutagogy, the educator acts as a facilitator or even as a co-learner by giving orientation and resources to the student-learner. Communication and teamwork skills are essential in learning processes in design contexts such as in educational contexts. By applying their competencies to new and unfamiliar learning situations, the student as the designer, has to be creative and flexible, and has to accept that failure and mistakes are an important and unavoidable part of a learning process. Dealing with incomplete information and ambiguous situations, requires designers and students to feel comfortable with uncertainty. The new DT-toolkit and m-course, final results of our D-Think research project, aim to give educators and learners this "heutagogy"-perspective of education and training, and offer them a method and toolkit to find new educational frameworks and teaching/learning methods.

Empathy phase

Knowing the context better

Stakeholder Map

A stakeholder is a person, group, organisation or system that affects or can be affected by a project or an organisation. The stakeholder map is used to categorise and visualise these individuals, groups or organisations, define their relationships and position them by levels of contributions and activities. In this project we divided the stakeholders or people involved into:

- ⇒ Research group composed of the ESAD team,
- ⇒ Toolkit Development composed of the Finnish team,
- ⇒ Quality Validation composed of the Belgian and Italian teams,
- ⇒ Pilot Training composed of the Spanish team,
- ⇒ Dissemination composed of the Portuguese team from Advancis,
- ⇒ M-Learning Course composed of the Polish team,
- ⇒ Legal representation of the European Agency,
- ⇒ Primary Users who are our target and future toolkit users, like HEI Educators, I&D Project Manager and trainers,
- ⇒ Secondary Users who are the learners and partners of the primary users, who can also be users,
- ⇒ Indirect Users who are the final students and trainees.

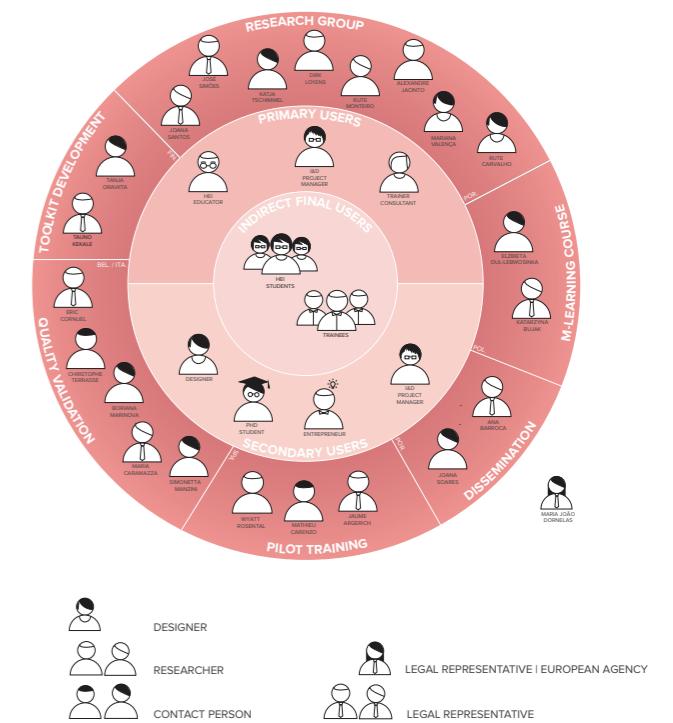


fig. 15 Stakeholder Map of the D-Think project

Informal Primary Research

To understand better the context of HEI educators, the ESAD research team participated, on February 12th, in the "Education in Portugal" conference with António Sampaio da Nóvoa*, the former dean of Lisbon University.

*António Sampaio da Nóvoa is an historian and educator. He was dean of the University of Lisbon and is currently Honorary Dean of the same institution. He holds a PhD in History from the University of Paris IV Sorbonne, as well as PhD in Educational Sciences from the University of Geneva.

This meeting was organised by professors and researchers from Aveiro University and researchers from the Centre for Didactic Research and Technology in the training of Trainers (Centro de Investigação Didática e Tecnologia na Formação de Formadores/CIDTFF).

The seminar's purpose was to create an informal discussion around pressing questions regarding education in Portugal, debating critically, profoundly and constructively the current state of education in general and more particularly official state education, allowing all participants to question the guest and encourage participation in the debate. In this seminar António Nôvoa claims that Portugal is tired. Starting in the late 1990's its educational system started showing signs of wear, which he characterised using three keywords: "Development", "Disaster" and "Too Much".

- Development: "Sufficient" and "necessary" is not enough when it comes to education.
- Disaster: Disaster in Education.
- Too Much: Portugal is spending too much on education without fulfilling its purpose.

According to Nôvoa, obsessive focus on merit and futile discussions about the quality of exams is once again jeopardizing general cultural development of the Portuguese population. The origin of these mistakes can be traced back to the policy on education of the last two years. The lack of a vision about culture as an inclusive project resulted in too many financial cuts on education even within the context of the ongoing financial crisis. Unfortunately it is today that we should be preparing for the huge changes we're about to face in the near future.

This seminar was accompanied by a round table dinner, where the dynamics of teaching in higher education were discussed. At the end of his intervention, when questioned about his knowledge about Design Thinking and how this could be applied to Education, Sampaio da Nôvoa recognised there's a great need to change educational methodologies.

Some of those novel methods are already being implemented in the private sector, but unfortunately not yet in the general public education system. It is mainly due to nervousness and misunderstanding, that those new methods are only being applied in elite education. However he acknowledges that design and designers can become valuable contributors for the creation of new approaches in education, specifically because designers are aware of ongoing and future trends in society. After the speech and the formal dinner, some

of our research team used the opportunity to interview in an informal way some of the present educators about their knowledge of Design Thinking, in general, and more specific as applied in education. Not one of the interviewed educators knew DT as a method for innovation or learning, they always associated DT with Product or Graphic design, as Sampaio da Nôvoa did as well. But after explaining the concept and potential of DT applied in education, every participant confirmed interest in this new methodology, and was very curious to know more about it.

In order to have a better understanding of the needs and opinions of HEI educators regarding their teaching and learning experience as well as the teaching methodologies used in the classroom, another informal primary research was conducted. This study consisted in the observation of educators and students' behaviour in an HEI environment completed by deeper informal conversation with the educators.

In theoretical classes the most common methodology was frontal teaching using visual presentation to orient the teaching process and debate oriented methods were used whenever considered useful. Occasionally group or individual exercises are completed under the teacher's orientation. In practical learning laboratory classes, the most common method is the individual and group orientation of students in requested assignments. Informal conversation with the educators made it clear that most teachers have great difficulty in selecting better learning methods to apply in class. Most of the teachers are aware of the necessity for change, most of all to motivate students to actively engage in the learning process and provide them with access to new teaching tools to do so.

This informal primary research was significant for the preparation of the interview with educators conducted in the next stage of the research process.

Deepening empathy

Interviews with images

The main research goal for the designed interview was to obtain feedback from teachers and trainers about their knowledge on new methodological approaches of teaching/learning, their needs and difficulties in the teaching/learning context and also to inquire about their knowledge of Design Thinking methodology. [fig.16]

Structured interview with educators

1. Sex F M

2. Age: _____

3. Profession: _____

4. Our research concerns tendencies of new methodological approaches of teaching-learning. Which of the following methods do you know and which do you apply?

	I KNOW	I APPLY
1. Flipped class room (theoretic preparation at home, practical application in class room)	<input type="checkbox"/>	<input type="checkbox"/>
2. Problem based learning (active learning by experiences)	<input type="checkbox"/>	<input type="checkbox"/>
3. Game based learning (learning through playing)	<input type="checkbox"/>	<input type="checkbox"/>
4. Design based learning (project based learning)	<input type="checkbox"/>	<input type="checkbox"/>
5. Blended learning (e-learning, online learning, m-learning, MOOCs)	<input type="checkbox"/>	<input type="checkbox"/>
6. Maker Space (hands-on learning through building things)	<input type="checkbox"/>	<input type="checkbox"/>
7. Connected learning (knowledge and expertise through digital connections)	<input type="checkbox"/>	<input type="checkbox"/>
8. Other (which?)	<input type="checkbox"/>	<input type="checkbox"/>

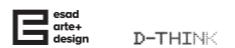
5. What is your opinion of the methodology you apply in teaching?

- 1. very efficient
- 2. efficient
- 3. not very efficient
- 4. inefficient

Why?

6. What are your principal needs in your teaching process?

7. And what are your greatest difficulties?



D-THINK

8. What suggestions or solutions would you offer to resolve the problems you mentioned above?
9. Are you familiar with the Design Thinking Method? If yes, please elaborate.
10. We will show you 5 images. Please choose 3 and comment on them freely.
- Image 1
- Image 2
- Image 3
- Image 4
- Image 5

Thank you for participating!

research process



fig.17 Images for question 10 of the interview

The technique Interview with images was used because it creates more empathy between questions and inquiries and it stimulates people to comment more freely without restrictions. Verbal questions usually provoke immediate answers, images allow a more fluent argumentation and a broader contextualisation of the answer.

Interview matrix

From the gathered data with the conducted interviews a table was constructed compiling all the information in order to facilitate posterior data processing. **[fig.18]** A total of 49 interviews were conducted by all the project researchers. The interviews were conducted with higher education teachers and trainers from various scientific areas. Of these 49 interviews, 26 were conducted with women and 23 with men. The age distribution was as follows in the graphic presented below. About 70% of the interviewees were between 30 and 50 years old.



fig.19 Infographics about the interviewed participants

The interviews were conducted with 42 higher education teachers and 7 trainers. The main focus of the research was to obtain feedback from higher education institution professors and teachers, hence the higher number of teachers among the target group, about 86% of the group questioned. When asked about their knowledge and use of new methodological approaches of teaching-learning, and presented with a list of the most relevant at the moment, the best known are: 1) Blended learning, 2) Problem based learning and 3) Game based learning; and the most applied are: 1) Problem based learning, 2) Design based learning and 3) Flipped classroom. The least known and used methodologies are Maker space and Connected learning. The graphic on the right **[fig.20]** presents in 2 colours the answers obtained as to the knowledge (K) and as to the practical application (A) of the new methodological approaches of teaching-learning asked about in the interview, in question number 4.

The interviewed people were also asked about other methodologies they knew and used, not listed in the interview, and to name them. We identified the following methods: learning by doing, personal tutoring,

role-playing, critical thinking, coaching, client based teaching, apprenticeship training, entrepreneurial learning and learning by research. When questioned about their own opinions of the methodologies they apply in teaching, 76% of the group questioned considered them to be efficient and 18% considered them very efficient. The most common evidence presented was the students'/trainees positive feedback and the satisfactory final evaluation results.

opinion about their own methodology applied in teaching



fig.21 Diagram of educators knowledge of Design Thinking

In spite of considering the learning process as efficient when questioned about the principal needs in the teaching process, the main concern is the need to learn new methods and tools to successfully motivate students/trainees in the learning process. Other main difficulties identified are the lack of adequate previous preparation of students' and difficulty in identifying and satisfying students needs, in their own individual learning process. The low motivation of students and trainees is a difficulty identified by several respondents who want to make classes more interesting, appealing, and related to real life scenarios in order to inspire students. A big gap between these two could be identified. The learning process is mainly considered efficient but there is a strong reference to the lack of interest and motivation by students and trainees. The need to define individual learning paths adapted to the student specific curriculum and professional goals is also mentioned so by some interviewees. When questioned about their knowledge of the DT methodology, 51% of the target group responded affirmatively, some knew little about it, others learned about it in their professional career. The final part of the interview consisted of commenting on 5 images **[fig.17]** related to different tools and techniques used in the Design Thinking methodology. The respondents were asked to comment freely. The majority identified the objective of the technique used, or some aspect of it, even if not knowing its exact designation. Some have used them before in different contexts, including in the teaching context.

BECAUSE USE A VARIETY OF METHODS ADJUSTED TO THE TOPIC AND KNOWLEDGE OF STUDENTS.	DELIVER CONTENT, METHODOLOGY AND ENTHUSIASM TO STUDENTS	DEALING WITH STUDENTS THAT ARE NOT INTERESTED AT ALL.	STRICTER RESTRICTIONS TO UNIVERSITY ACCESS, MORE VARIETY FOR STUDENTS SO THEY DO NOT HAVE TO TAKE MY CLASSES IF THEY ARE NOT INTERESTED.	N	LOOKS LIKE SOME SORT OF MINDMAP, HARD TO UNDERSTAND AS I DON'T SPEAK PORTUGUESE.	LOOKS LIKE A NICE PLAYMOBIL PLAYGROUND, ACTUALLY I HAVE NO IDEA HOW THIS COULD HELP WHEN TEACHING
IT FACILITATES LEARNING THROUGH DOING	GET STUDENTS INVOLVED INTO ACTIVE BUILDING OF SOMETHING AND SUPPLY THEM WITH TOOLS	NO GREATEST DIFFICULTIES, MAY BE JUST LACK OF TEACHING TIME	D	S	IT IS A CREATIVE WAY OF SOLVING PROBLEMS, WHICH IMPLIES CONSTRUCTING / BUILDING / DIGITAL CREATION OF A SOLUTION	THIS IS THE THING I REALLY LIKE BECAUSE IT HELPS TO SEE THE WHOLE PICTURE (GOOD FOR OUR PROJECT IN CITY CO-DESIGN)
THE METHOD HAS BEEN SELECTED BASED ON THE LEARNING OBJECTIVE	AT THE MOMENT THE BIGGEST NEED IS TO SHOW THEM THE RIGHT QUALITY DIGITAL MATERIAL, IT'S NOT MY EXPERTISE TO EDIT WELL ENOUGH.	I HAVE STUDENT ORIENTATION - CLIENT RELATIONSHIPS, BUT I DON'T KNOW WHAT CLIENTS WANT STUDENTS LEARN THAT MAYBE OUR APPROACH IS NOT THE ONE ONE OR THE BEST THEY START LEARNING COMPLEXITY + MULTIDISCIPLINARY	S	A SORT OF COLLAGE FOR ME IT IS TARGET GROUP ORIENTATION + RAPID TRIALS + PROTOTYPING	I CHOSE THIS DUE TO THE SIMPLE NICE THESE ... WORK METHODS ... USE THIS IN TEACHING A STUDENT TO UNDERSTAND THESE ISSUES ... THIS IS VERY MUCH TODAY IN MY TEACHING	INTERESTING DUE TO SPATIAL BEING CONCRETE, I'VE BEEN TRYING TO USE IT IN MY TEACHING, I THINK STUDENTS COULD LIKE THIS A LOT. I WOULD LIKE TO USE, I'VE USED E.G. SERVICE DESIGN, BUT NOT SPATIAL
STUDENT FEEDBACK SHOW THAT LEARNING RESULTS ARE TOP LEVEL	1) PRACTICE, COMPANY NEEDS, STUDENTS NEEDS, EDUCATIONAL NEEDS, WHAT IS DEMANDED - LEARNING, YOU HAVE TO START LOOKING AT THE UNIVERSITY'S DEFINITION ON THE LEARNING CONCEPT	1) HOW TO MANAGE A MULTICULTURAL GROUP. 2) COMMUNICATION PROBLEMS	1) INTERCULTURAL TRAINING 2) LANGUAGE TRAINING	S	USER ORIENTATION IN TEACHING THROUGH THEIR EYES. ALSO USE "HANDS ON" TOOLS, USE DIFFERENT PERSPECTIVES, CREATIVE TOOLS, ETC...	MINDMAP / TREE ANALYSIS, WHERE WE CAN GET THE HOLISTIC PICTURE, HOW THINGS ARE RELATED TO EACH OTHER.
0	SPACES WHERE COLLABORATION CAN HAPPEN WHERE PEOPLE CAN GET TOGETHER, SPACES FOR DIFFERENT KINDS OF PEOPLE, FACILITIES FOR DESIGN, COMMUNICATION, AND PROTOTYPING, NEW TECHNOLOGY	LACK OF ... EVERYTHING DOES NOT WORK FOR EVERYBODY, STUDENTS ARE ALL DIFFERENT INDIVIDUALS, PLAN THE CURRICULUM SO THAT IT JOINS EVERYONE.	THE SUBJECT MODULES SHOULD SUPPORT EACH OTHER AND THE RIGHT MODULES SHOULD BE AVAILABLE AT THE RIGHT TIME FOR STUDENTS, EVERYTHING UNNECESSARY SHOULD BE ELIMINATED FROM THE CURRICULUM	S	TANGIBILIZING THE PROBLEM, INCUBATING IDEAS, WORKING IN THEIR EYES. ALSO USE "HANDS ON" TOOLS, USE DIFFERENT PERSPECTIVES, CREATIVE TOOLS, ETC...	MINDMAP, SEARCHING FOR CONNECTIONS BETWEEN THINGS, SORTING/SELECTION PROCESS, POSITIVE AND NEGATIVE ASPECTS, THE BEGINNING PHASE, SEEING THE BIG PICTURE
	FUNCTIONAL FACILITIES, DIVERSE LEARNING ENVIRONMENT	TO GET SO CLOSE TO INDIVIDUAL STUDENTS THAT EACH OF THEIR NEEDS CAN BE IDENTIFIED AND SATISFIED.	EACH TASK SHOULD FIT IN THE PROFESSIONAL CONTEXT AND IF APPLICABLE IN PRACTICE, PERSONALIZATION OF THE CURRICULUM FOR EACH STUDENT.	S	RANKING A SPECIFIC THEME.	DEMOCRATICATION OF A SPACE/ SITUATION, GAMIFICATION
	SPACE AND FACILITIES, COLLABORATORY, DOING ... LEARNING TOGETHER	SCHEDULE AND RESOURCE MANAGEMENT, ACTIVATING STUDENTS	EFFICIENT PLANNING INFORMING COMMUNICATION	S	MINDMAPPING, FROM PRODUCTION TO THE FINAL OUTCOME.	ANALYSING POSITIVE AND NEGATIVE FACTORS, LEARNING SCENARIOS, PROBLEM-BASED LEARNING, EXPERIENCE-BASED PROBLEM-SOLVING

fig.18 Snapshot of the matrix for analysing the interview results

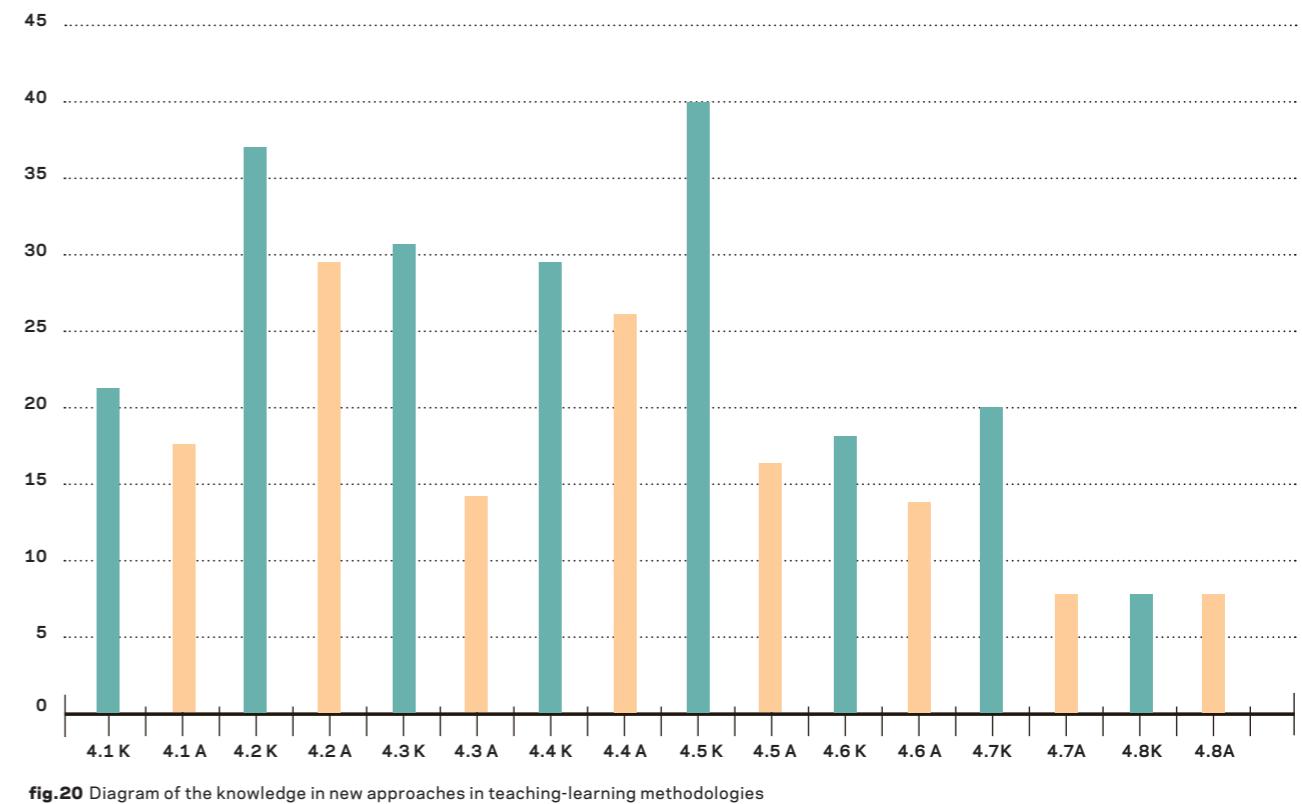


fig.20 Diagram of the knowledge in new approaches in teaching-learning methodologies

Elaboration of Persona Cards

From the results obtained in the conducted interviews, it was possible to characterise three different personas which represent the interviewed target group. The three personas [fig. 22] are two higher education professors and one professional trainer. Rita is a lecturer and researcher in Psychology in a University and also works in a big company. She is very interested in improving her teaching methods and using her company work experience to do so, experimenting with new teaching/learning methods in class. Ricardo is a professor and research coordinator in the field of Physics. One of his main concerns is to provide a successful learning process for his students. Exchanging experiences with collaborators in other countries is very important for him as a teacher and researcher. Last, but not least, Rui is a trainer in Vocational Education and Training courses. He likes being a trainer, especially dealing with young people with different motivations, but with a common goal, to acquire skills and learn a job. Rui is always searching for new tools to help him in the training process. Motivating different kinds of students isn't easy, and sometimes he feels lost and without a clear guidance in the teaching/learning process.

	<i>I think it would be very important that every teacher has more training in new learning methods, but this would imply a paradigm shift regarding the evaluation of our activity.</i>
name Rita Fonseca	personal story - a day life Rita has a PhD in psychology and she teaches and researches in the Faculty of Psychology in the University of Oporto. She's a single mother, so every day, before going to work, she must take care of her kids, preparing their lunch packets and taking them to school.
age 46	Rita's weeks are full but Tuesday, although it is a very busy day, is her favourite. Today is that day after leaving the children at school, Rita goes to Vodafone where she's developing a project in order to improve their labour practices. This professional dimension allows her to have effective contact with another reality and to acquire essential skills for her classes. For Rita, it is very important to be able to share real live practical experiences. This morning she'll have a meeting with the Sales Director and then she'll have the opportunity to see firsthand the work of the company's sales representatives.
profession social science educator	At college, early in the afternoon she'll meet with the coordinator and other members of her research group in order to continue the preparation of the next International Congress of Psychology, University of Oporto. This is a project that has required a lot of her time, because it is intended to have a wide involvement of guest speakers.
education Psychology PhD	At 5 pm Rita starts classes with a group of students that she finds very interesting, and with whom she tries out new learning methods, which is very rewarding for her. The enthusiasm of both parties guarantees a lively discussion and promotes a thorough development of the topics under review. It is at 7 p.m., that Rita again assumes the role of mother. She brings her sons home, prepares their baths, helps her older son with homework, gets dinner ready and then puts them to bed with a story. At 9 pm Rita begins to organise the next day.
knowledge work psychology / statistics	
interests / hobbies cultural events	
frustrations difficulty to manage family and work	
goals time for family	
top of academic career	

	<i>What I have learned about Design Thinking seems great. I work with big classes of trainees with different backgrounds and different reasons for choosing VET education. Most of the time it's difficult to motivate them. I'm excited with the Design Thinking mindset, because it seems that it's application will improve the classroom experience.</i>
name Rui Lambert	personal story - a day life Rui is a trainer in vocational education and training courses. He works in 2 different technological and professional schools that offer this kind of courses. During day time he works in one school, where he is trainer and also, pedagogical coordinator of the Industrial Maintenance Technical course, running on full-time classes. This course prepares and qualifies students for work and leads to a diploma as a professional technician. He trains young students to become specialised technicians in repair and maintenance of machinery in the metallurgy industry.
age 50	Today he starts at 9:00h with the monthly teachers meeting, where the relevant events of the month are discussed and next month activities are planned. He tries to do all the coordination part of his work during the morning, because he has classes during the afternoon, starting at 14:00h.
profession Trainer in VET	He likes being a trainer, especially dealing with young people with different motivations, but with a common goal, to acquire skills and learn a job, and more rapidly access the professional market.
education Mechanical Engineer	Rui is also a trainer in another school, in evening classes. The schools are not located in the same city, which means that Rui has to spend some time travelling from one to the other, 3 times a week. He leaves at 18:00h to start working at the other school at 19:30h. In these evening classes he has older students, sometimes unemployed, which pose a different training challenge and demand a different approach. But Rui likes challenges, or he wouldn't have this job. Normally, on these days he arrives home around 21 pm, which doesn't make his family very happy. He can still spend some time with his wife and teenage daughter before going to bed.
knowledge Mechanical Engineering and Industrial Management	
interests / hobbies Running and Gym	
frustrations Working long hours and lack of acknowledgement	
goals working normal week hours, having more family time	



name Ricardo Teixeira	personal story - a day life First job of the day – ensure that he is in the right place! Ricardo works both as a lecturer in the Physics Department at University Porto (FEUP) and conduct research in a Portuguese Research Institute INEGI.
age 55	Most days, Ricardo concentrates on teaching activities in the morning and then head to INEGI in the afternoon to meet with his team of researchers that makes up the Quantum Optics Group.
profession science educator and research	This morning he is with a large group of budding engineers giving a lecture on mechanics. After the lectures, he spend a couple of hours helping to bring together compatible students, projects and supervisors. The match is important to make sure that the student has an enjoyable experience, learning new skills that he or she will use in the workplace or if they choose to study for a higher degree such as an MSc or PhD.
coordinator	
education Physics PhD	Once teaching is over, he walks to the research laboratory to see how things are going there. The lab is a hive of activity with a number of experiments running. In one experiment they explore novel types of laser systems, known as microlasers due to their size. Ricardo needs to organise a trip for himself and one of his research students to visit their collaborators in Germany and Austria next month. The research group meet to discuss who should travel and the benefits to the people involved - there are usually more volunteers than places so this is a tough decision to make. At 4pm he's off to meet a visiting US professor who is giving a talk on "55 Years of the LASER" to celebrate the laser's historic birthday since it first came into operation in 1960. This is part of a series of seminars for all the staff and students, which Ricardo organises, so he is delighted to see a good turn out.
knowledge nuclear Physics	7pm and time to leave. Ricardo lists all the jobs to be tackled the next day and sends e-mails to the researchers to make sure they know what to do.
quantum physics	Another work day is over and he's off to the gym where his personal trainer is waiting. At home around 8:30pm, having dinner with his wife and his 22-year-old daughter.
interests / hobbies running, gym with a personal trainer	
traveling	
frustrations	
wife doesn't allow to buy a motor bike	
goals time for traveling and leisure	

fig. 22 Persona cards

Moodboard

The online platform Pinterest was used as a canvas to perform visual brainstorm session using only images of data representation, report layouts and other graphical media as the source for inspiration. The resulting collection of images were put to a vote between all the members of the research team and the subsequent set was used to elaborate a moodboard for the production of the research report. [fig. 23 e 24]

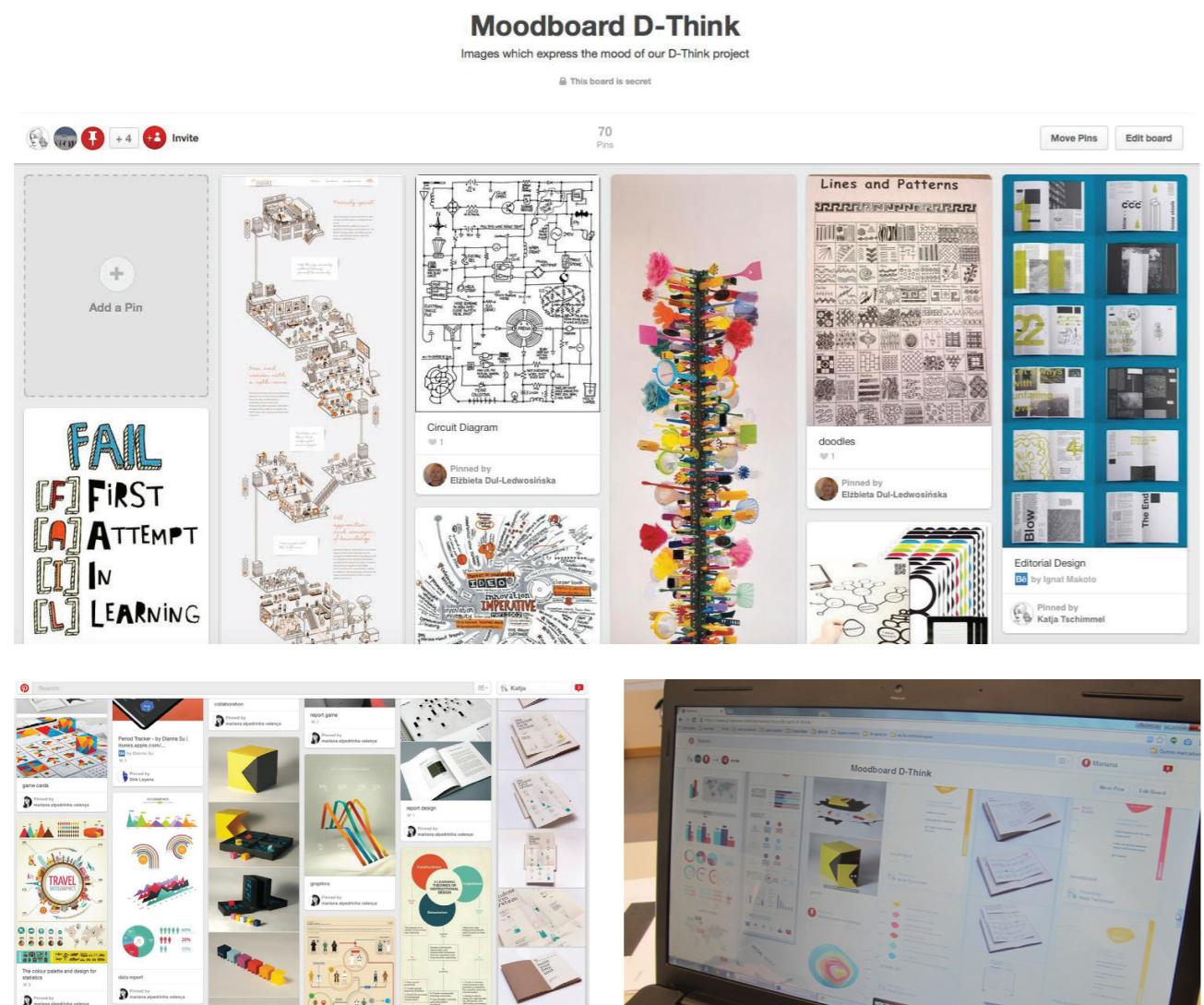


fig. 23 Online moodboard in Pinterest conceived by all partners



fig. 24 Final moodboard printed out for the idea generation

Experimentation phase

In the Experimentation Phase it was very important to differentiate between the idea generation for the Research Report and idea generation for the DT toolkit to be developed by the Finnish partners. The diagram of [fig. 4](#) explains the three parallel processes of the D-Think project.

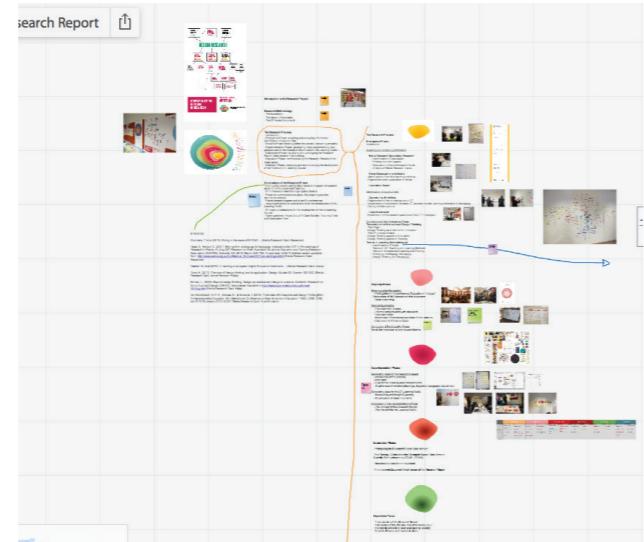
Generating ideas for the Research Report

Brainwriting and Clustering

The development of this research project and its organisational structure is based on the Evolution 6² DT model. This is a novel approach in design research and therefore an innovative approach to the standard research report model has to be questioned and a different approach in its elaboration tested.

Within the framework of this project, the elaboration of the research report itself was also developed within the mindframe of Design Thinking, based on the first three phases: Emergence, Experimentation and Elaboration. Some standard DT tools and some very specific tools and techniques were used in the preparation of the structure and the graphical identity of the research report. The process for the development of the research report started with a standard brainstorm. The expected outcome of this exercise was a set of ideas for the visual strategies in the presentation of the research report. This could either be a process or a series of actions, types of media or a series of techniques to represent information. All the suggestions were clustered on relevance and applicability on metaphoric layout simulating a thermometer, visually attributing relative importance to the proposed media. Considered most pertinent were: images, storytelling, storyboard, research process orientated, infographics and game style report. The results of this small exercise were the input for graphical experimentation, first on the platform Realtimeboard and later in the

conceptual phase of the design process for the final graphical identity of the research report.



[fig. 25](#) Draft for the research report on Realtimeboard

Generating ideas for the DT Learning Toolkit

Brainwriting and Clustering

The framework of the new toolkit is also based on the Evolution 6² DT model for orientation of the creative planning of a human centred teaching and learning process [\[fig. 26\]](#). A modified brainstorming session was organised in order to get a better understanding of the set of tools which could be used for the planning of such a process. This Goal Oriented Brainstorming (GOB) is not as much focused on novel ideas as it is used to create different structures for toolkits using existing tools and techniques, sometimes out of their usual context and in combination with ideas for novel tools and techniques. The GOB was orientated by three of the (reformulated) research questions for this project and by one additional question (the last one):

- * How can DT improve the learning process?
- * Which kind of DT tools are appropriate in teaching and learning processes?
- * How can a new DT Toolkit help educators to improve the learning competence and capabilities of their learners?
- * Which DT tools help to create a positive classroom experience (in theory and practice based classes)?

The original set of tools described and applied in the Evolution 6² DT model (Tschiimmel, 2014a) was complemented with tools described in the general DT literature (Curedale, 2012; Kumar, 2013; Van Boeijes, 2013; Sanders & Stappers, 2012; IDEO, 2009) and in the research project specifically focused on DT in education (IDEO) a matrix was constructed based on the six phases of the Evolution 6² DT model as vertical columns and a set of activities which are all part of the planning for a teaching and learning process. Four action-intended categories were then applied as horizontal rows and labelled: Getting Insights, Sharing Insights, Ideation and Organisation of Ideas/Selection.

Within each phase those categories refer to tools which are either exploration tools or evaluation tools. The GOB was an idea generating process with a lively but structured discussion between the multidisciplinary team involved in this part of the research. The raw results of this brainstorming exercise were collectively revised. Actions, tools and techniques were clustered along the subsequent timeline of the Evolution 6² DT model and amended. Some of the tools and techniques were re-framed to adjust to the particular needs and expected outcome for this particular toolkit. The matrix was then discussed, evaluated in detail and restructured [\[fig. 27\]](#).

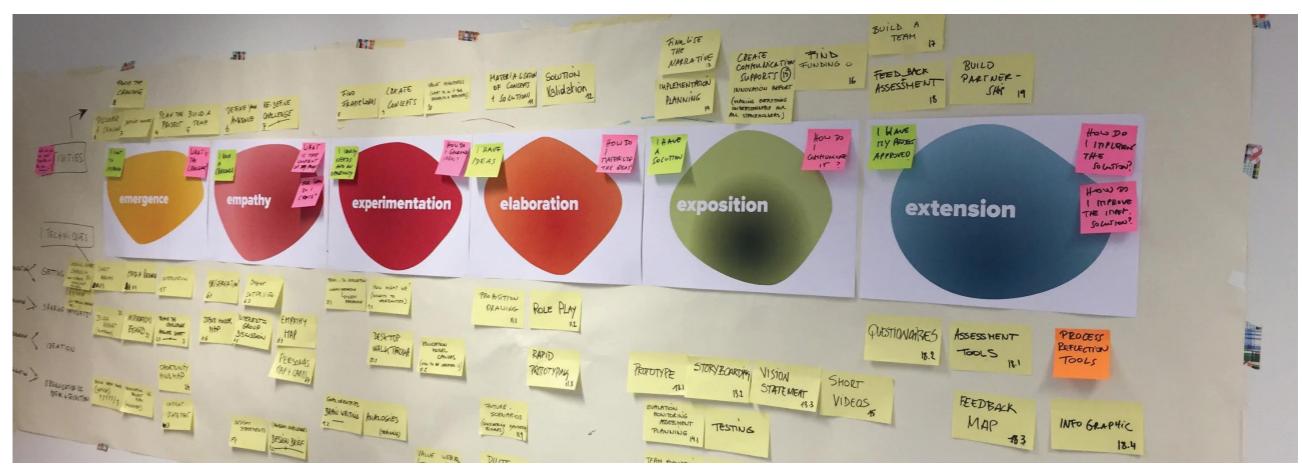
Organisation of ideas in a matrix

Although the initial model of the matrix was planned with four categories for each phase, this set-up proved to be unnecessarily complex, inducing the notion that each phase in a DT model needs necessarily four types of actions to be completed, which is not always true and does not apply in this case. Therefore in the revised matrix those four categories were abandoned, and exploration and evaluation tools were colour coded.

The final revised matrix [\[fig. 28\]](#) describes a sequential set of actions along all six phases of the Evolution 6² DT model and proposes a collection of DT tools and techniques appropriate for the accomplishment of those actions. This series of DT tools and techniques are the first proposal for a toolkit, further ideation will complement, optimise and tweak the overall structure of the DT Toolkit for education.



[fig. 26](#) Organised Brainwriting



[fig. 27](#) Brainwriting and selection for the toolkit

First draft for the D-Think Toolkit

	EMERGENCE	EMPATHY	EXPERIMENTATION	ELABORATION	EXPOSITION	EXTENSION
activities	Discover a Challenge	Frame the Context/People	Create Concepts	Solution Materialisation	Create Communication	Implementation Planning
techniques tools methods	Follow your Nose – Gut Feeling + Experience	Inspiration Board	Observation	From... To Exploration Current to New Perspective	Desktop Walkthrough	Pilot Test
Leading Expert	Buzz Report	Image Interview	Design Brief	How might we? Insights to Opportunities	Proposition Drawing	
SWOT Analysis	Frame Challenge Sheet	Empathy Map	Innovation Project Plan	Education Model Canvas	Role Play	Evaluation Matrix
Media Research	Oportunity Mind Map	Interest Group Discussion	Goal Orientated Brainwriting	Value Web (Stakeholder Exchange)	Rapid Prototyping	Vision Statement
Interview	Intent Statement	Stakeholder Map	Analogies	Future Scenarios		
			Personas Map + Cards			

fig. 28 First draft for the D-Think toolkit

Elaboration phase

D-Think
Design Thinking Applied to Education and Training
ERASMUS + KA2 Strategic Partnerships

Research Report Structure

Introduction to the Research Project

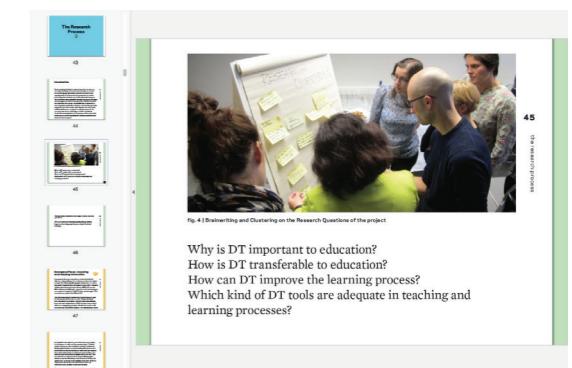
Introduction to the Research Project



fig. 29 Prototyping the Research Report



fig. 30 Images from two digital beta versions



Why is DT important to education?
How is DT transferable to education?
How can DT improve the learning process?
Which kind of DT tools are adequate in teaching and learning processes?

Exposition phase



fig. 31 Preparation of a scientific presentation of the D-Think research process

Programme
ERASME + KA2 Strategic Partnerships

Project Title
Design Thinking Applied to Education and Training

Project number
27521-LA-1-2014-E4AKA-ECHE

Partners

- ESAD | Escola de Artes e Design [Portugal]
- Advancis Business Services [Portugal]
- Vaasan ammattikorkeakoulu VAMK Ltd, University of Applied Sciences [Finland]
- ISTUD Business School [Italy]
- Akademie Haus der Techno-Economia w Łodzi [Poland]
- Venture Hub [Spain]
- EFMD | European Foundation for Management Development [Belgium]

Project start: 01-09-2014 Project End Date: 31-08-2017

D-THINK

Media Research

TrendMetric

Inspirationboard

Mind Mapping - identifying opportunities for the project

Final Opportunity Mind Map

Discussing the Intent Statement of the Research Report: Reviewed Research Questions

Peer reviewed high quality Desktop Pages

Media

Understanding better our partners:

- Conference Dinner about Education in Portugal
- Structured interview
- Interview matrix

Structured interview with images

MoodBoard - Stakeholder Map

Persona Template - Persona Cards

Generating ideas for the research report through: Brainwriting, Brainstorming, Clustering, Analogies, Experimental Drawing.

fig. 32 Storyboard of the research process

The Exposition Phase of the E6² DT model is characterised by the application of techniques which help to communicate new concepts and/or material solutions. This DT-phase is essentially related to the dissemination of the research process and outcome. As the entire D-Think research project is divided into three nearly parallel processes [see fig. 4], at this stage it becomes clear that the Design Thinking process is strongly iterative.

Communication material related to the Research Report are Diagrams [fig. 1, 2], informative Tables [fig. 6 -

Extension phase

EVOLUTION 6²
Mindmap Design Thinking Model

research process

Media

Tool Kit

M-Learning

Research Report

Activities

Activities	Observation	Contextual Inquiry	Definition	Conceptualization	Elaboration	Implementation	Evaluation
Observation	Observe the situation	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Contextual Inquiry	Contextual Inquiry	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Definition	Interviews	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Conceptualization	Interviews	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Elaboration	Interviews	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Implementation	Interviews	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate
Evaluation	Interviews	Interviews	Define the problem	Create Concept	Elaborate	Implement	Evaluate

Generating ideas for the DT Learning Toolkit through: Brainwriting, Brainstorming, Clustering, Analogies, Experimental Drawing.

Once a new concept is presented to and accepted by a community, it has to be implemented. Various communication supports, such as articles, flyers, sites, etc. can help to make the innovative character of the D-Think project understandable. For the research team at ESAD, the Extension Phase signifies supporting the development of the D-Think toolkit (its specification, elaboration, testing and dissemination) and the development of the m-Learning Course. In the

last year of the project, visual material will be necessary for training for the trainers program, the pilot testing of the m-learning course and its dissemination. Questionnaires and a Feedback Map will be realised to improve the outcome of the D-Think project.

4
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The Concept Design Thinking

The Concept Design Thinking

The following text about the origin and evolution of the concept Design Thinking and the description of its main characteristics and toolkits is the result of the systematic literature search and its bibliographic database in the Emergence Phase of the research process. The most quoted DT models are presented and compared.

The Origin

Design was always a catalyst for innovation processes in product and service development. But over the last 10 years, with more and more publications about Design Thinking, the term has gained popularity in engineering fields, business media and finally in the area of education. Design Thinking became a label for the awareness that any kind of organisation can benefit from the designers' way of thinking and working. Two decades before becoming a popular method for innovation, design thinking (at that time written in lower case) had been defined and studied by an international research group, solely as the cognitive process of designers (Cross, Dorst & Roodenburg, 1992; Eastman, McCracken & Newstetter, 2001). The objective of these studies was to get more insights into the important attributes of Design Creativity. Instead of looking for universal design methods (as the movement of the 1960s and 1970s had done), research in design thinking is interested in identifying the essential mental strategies of designers while working on a project. Born in the 1990s, the research movement in design thinking is still in continuous development, trying to identify the fundamental reasoning patterns behind

design and looking at the core design practices. Kees Dorst (2011), for example, identifies in his paper "The core of 'design thinking' and its application" (chosen as a high quality desktop paper for this research) the creation of frames as the core of design practices. Lucy Kimbell (2009, 2011, 2012) tries in her several papers to build a bridge from design thinking as a cognitive process to Design Thinking as an innovation process where designers meet practitioners from other disciplinary fields.

In the last 10 years (2005 - 2015), the concept of design thinking has been stretched, and is now free of its domain limits. Today, Design Thinking (now written in upper case) is understood as a complex thinking process, expressing the introduction of design culture and its methods into fields such as business innovation, social innovation or educational innovation. Two authors and their books have been central to the reconfiguration of design thinking: *Change by Design: How Design Thinking Transforms Organisations and Inspires Innovation* by Tim Brown (2009), CEO of IDEO, one of the world's most influential design consultancies, and *The Design of Business: Why Design Thinking is the Next Competitive Advantage* (2009) by Roger Martin, Dean of the Rotman School of Management in Toronto, with a background in management consulting. Although both authors define and describe Design Thinking differently, they both explore its role and potential within organisations. Martin even claims in an interview carried out by Dunne, that Design Thinking skills should be taught in MBAs, as

MBA students have to learn collaborative skills, and to get a deeper understanding of the user experience (Dunne, 2006: 514).

Design Thinking as a method for innovation

Since 2005, Design Thinking (DT) is not only seen as a motor for innovation promoted by designers, but it offers new models of processes and toolkits which help to improve every creative process, carried out not only by designers, but in multidisciplinary teams in any kind of organisation. According to Kimbell (2009), some governmental institutions, such as the British Design Council, promote Design Thinking as a key-player in innovation processes. In one of his first articles about Design Thinking, Tim Brown (2005) defines DT as an inherently prototyping process: "Once you spot a promising idea, you build it. In a sense, we build to think". According to Brown (2009), Liedtka & Ogilvie (2011) and Tschimmel (2012), the new use of the term DT, specifically the combination of "thinking" and "design", offers fields such as Innovation Management the opportunity to apply design tools to other problem-solving-contexts not directly related with the appearance and functionality of artefacts, but with the form of businesses, services and processes. In this line of thought, in education and training, the combination of "thinking" and "design" signifies a big potential for being integrated into new learning approaches.

The main characteristics of Design Thinking

Traditionally, design thinking relies on the designer's capacity to consider at the same time: 1. Human needs and new visions of living well; 2. Available material and technical resources; and, 3. The constraints and opportunities of a project or business (Tschimmel, 2012). According to Pombo and Tschimmel (2005), the integration of these three factors demands from the designer the ability to be at the same time analytical and empathic, rational and emotional, methodical and intuitive, oriented by plans and constraints, but remain spontaneous. Some design researchers call this kind of dualistic reasoning designers' use 'abductive thinking' to differentiate it from the rational deductive and inductive reasoning (Martin, 2009; Cross, 2011; Dorst 2011). Abductive reasoning is a concept developed by the philosopher Charles Sander Pierce, who defended that no new idea could be produced by deduction or induction using past data. Thus, abductive thinking is thinking in new and different perspectives and about future possibilities, which do not fit into

existing models. And it is a way of thinking in which feelings and emotions are just as important as rationality.

Related to the concept of abductive thinking is the important role of perception in Design Thinking. Since visual perception is the dominant among the senses, perception in and through images plays a special role in Design Thinking. This is emphasised by several design researchers, such as Goldschmidt, Lawson or Cross. Lawson (1986, 2004) and Cross (2011) suggest that designers usually apply sketches, drawings and material models to explore the project problem and solution together. The act of visualising their thoughts seems to clarify designers' ideas, an observation which Goldschmidt confirms (1991, 1994, 2003). In her various publications on the central role of visual representation in the formation and development of ideas in a design process, Goldschmidt defends that sketching is an extension of 'mental imagery'. By visualising his thoughts about aspects of the project, the designer expands the problem space of the task, to the extent of including and even discovering, new aspects.

In the same way that sketching helps the designer to think and elaborate ideas, early prototyping is another way of visualising and testing new solutions, and thus is a principle, and tool, of Design Thinking. It is a visual manifestation of concepts, the transformation of an idea in a testable model, and thus, according to Liedtka and Ogilvie (2011) indispensable to the creative design process. And as the designer never has enough information about a project, rapid prototyping allows testing of early product or business details, forms and nuances. And as rapid prototyping materials are cheap, it permits early failure. The understanding and acceptance that failure and mistakes are important elements of Design Thinking, differentiates DT from the traditional way of thinking in business. Dealing with incomplete information, with the unpredictable, and with ambiguous situations, requires designers to feel comfortable with uncertainty (Pombo & Tschimmel, 2005).

Another fundamental characteristic of Design Thinking is its human-centred approach, which expresses itself in the collaborative way designers work and in participatory methods of co-creation. In design practice the American design agency IDEO is an excellent example of this change of approach (see Brown 2009; IDEO, 2009, 2015). Their HCD-model applied in social innovation processes, foresees the involvement and participation of impoverished communities in the whole design process, from identifying the problems

and challenges, to idea generation, prototyping and evaluating the design outcomes. Designers not only develop innovative solutions by working in teams with colleagues (other designers, engineers, marketing specialists, etc.), researchers and stakeholders, but also often in collaboration with the final customers and users of their creations.

The DT process models

Following on from classical design methodology, the design process has been divided into several stages to facilitate the planning of project tasks, collective and production activities, and timetables. The first references to a multiphase structure of the creative process in general, go back to Poincaré (1924), who through his reflections on his own creative thinking process in solving mathematical problems, gave the impulse to Wallas (1926) to divide the creative process into four phases: the preparation, the incubation, the illumination and the verification phase. This classification was the starting point of the research movements into design creativity, which looked for new models to best describe the phases of a creative problem solving process (Tschimmel 2012). As shown by several design researchers, the classification and respective visualisation of the different phases of the design process depend mainly on the methodological paradigm in which the creative process in design is analysed and described (Dorst & Dijkhuis, 1995; Dorst, 1997; Tschimmel, 2011a).

In the domain of Design Thinking applied in innovation, several process models have been published and defended as the most appropriate. Some of the best known models are the 3 I model (Brown & Wyatt, 2010) and the HCD model (<http://www.ideo.com/work/human-centered-design-toolkit>), both developed by IDEO, the HCD model in 2 different versions, the Double Diamond model from the British Design Council (<http://www.designcouncil.org.uk>), the Design Thinking model of the Hasso-Plattner-Institute (http://www.hpi.uni-potsdam.de/d_school/designthinking) and the Design Thinking model of the University of Stanford. The last are both related to the d.school in Potsdam, Germany, and in Stanford. Until now (2015) the only existing DT toolkit for Educators was also designed by IDEO in collaboration with the Riverdale School. In the following, all these models will be briefly introduced and at the end, discussed.

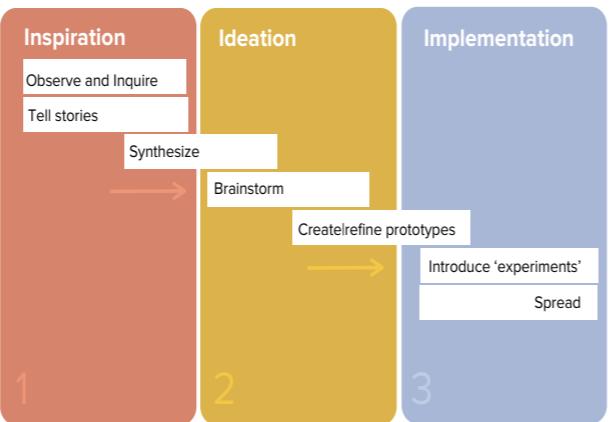


fig. 33 The DT model of 3 I's (IDEO)

IDEO's 3 I model

The DT model of 3 I's (Inspiration, Ideation, Implementation) was developed by IDEO in 2001 in the context of service and social innovation. As the design agency was increasingly being asked to work on problems far removed from traditional design (health care, learning environments, etc.), they wanted to distinguish this new type of experience-oriented design work from industrial design (Brown & Wyatt, 2010). Inspiration, the first Design Thinking phase of the model, includes the following design activities: the identification of the design problem or opportunity, the elaboration of the design brief to give the design team a framework, and the observation of the behaviour of the target group in their daily living environment. After identifying the context by observation and design research, the Ideation phase of the Design Thinking process starts: an interdisciplinary team goes through a process of synthesis in which they distil what they have observed and learned into insights that lead either to opportunities to change, or immediately to new solutions. During this brainstorming process, visual representations of concepts are encouraged to help others to understand complex ideas. The third phase of IDEO's DT model is Implementation, the phase in which the best ideas are turned into an action plan. According to Brown and Wyatt (2010), prototyping is the core of the implementation process. Through prototyping, new ideas and material solutions are tested, iterated and improved. After the final

IDEO's HCD models

(version 2009 and version 2015)

In response to a call from the Bill & Melinda Gates Foundation, IDEO developed in 2009 another DT model, first as a toolkit for NGOs and social enterprises that work with impoverished communities in the developing world (Brown & Wyatt, 2010), and later on (2015) as a toolkit for every designer:

The HCD-toolkit for social innovation:
IDEO (2009). HCD Toolkit: a step-by-step guide to the elements of human-centred design. 2nd released & revised by IDEO (in October 2015 it was no longer available for download).

A recent version of the HCD-toolkit, but this time reformulated as a Design Toolkit, elaborated for the use by designers:

IDEO (2015). The Field Guide to Human-Centred Design. 1st Edition. Available in <http://www.designkit.org/> (03/10/2015).



fig. 34 Comparison of the 2 versions of the HCD model (IDEO, 2009: 8 and 2015: 12)

a) IDEO: The HCD-toolkit for social innovation. The first version of the HCD toolkit shows how to use the Human-Centred Design approach to overcome challenges and develop innovative solutions in non-profit businesses, more specifically in the developing world. The model is also based on 3 phases which form the acronym HCD, which at the same time stand for Human-Centred Design and Hearing, Creating and Delivering, the 3 phases of the model.

The user is guided through a participatory design process, which is supported by activities such as building listening skills, running workshops, and implementing ideas. The first version of the HCD toolkit is seen as a step forward in sharing the practice of human-centred design with the social sector. In its introduction was the following explanation of the HCD approach: “Human-Centred Design (HCD) will help you hear the needs of constituents in new ways, create innovative solutions to meet these needs, and deliver solutions with financial sustainability in mind.” (IDEO, 2009) Through a series of methods, activities, and resources, the toolkit can empower individuals and organisations to become designers themselves and enable change in their own communities.

The process of Human-Centred Design starts with a specific Design Challenge and moves from concrete observation of people, to abstract thinking while uncovering insights and themes, and then back to the concrete thinking while describing tangible solutions

[fig. 35]

The HCD toolkit adopts a small set of rules for creating an environment to facilitate innovation: Building multi-disciplinary teams, with no less than 3 and no more than 8 individuals; Using dedicated spaces to focus on the challenge; Planning finite time frames, with a beginning, middle and end.

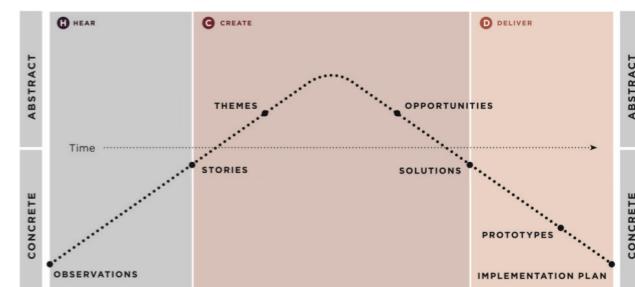


fig. 35 HCD Process diagram (IDEO, 2009: 8)

b) IDEO: The design toolkit for Human-Centred-Design. The second version of the HCD toolkit, also developed by IDEO, does not promote itself as a descriptive guide for a Design Thinking process. The term Design Thinking is not even mentioned. It is however very similar to the previous toolkit, although it is no longer specifically focused on NGO's and developing world problems. In fact a human-centred design process should not be singled out for particular problems within a specific context, but should be useful for almost any kind of design process. This HCD field guide is therefore more complete than the first HCD toolkit, and it should be possible to use its techniques in the design of educational programmes, learner outcomes and active learning strategies.

The field guide offers problem solvers a chance to design with communities, to understand people, to dream up a score of ideas, and to create innovative solutions based on people's actual needs. Being a human-centred designer is about believing that as long as designers stay grounded in what they have learned from people, the teams can arrive at a new solution for a real world need. According to IDEO (2015), human-centred designers think and test, fail early and often, and spend a surprising amount of time not knowing the answer to the challenge at hand. They are optimists and makers, experimenters and learners, they empathise and iterate, and they look for inspiration in unexpected places. They make their ideas tangible, test and refine them. Interesting in this field guide is the description of seven complementary mindsets for a Human-Centred-Design process: Empathy, Optimism, Iteration, Creative Confidence, Making, Embracing Ambiguity, and Learning from Failure.

INSPIRATION	IDEATION	IMPLEMENTATION
Frame Your Design Challenge	Download Your Learnings	Live Prototyping
Create a Project Plan	Share Inspiring Stories	Roadmap
Build a Team	Top Five	Resource Assessment
Recruiting Tools	Find Themes	Build Partnerships
Secondary Research	Create Insight Statements	Ways to Grow Framework
Interview	Explore Your Hunch	Staff Your Project
Group Interview	How Might We	Funding Strategy
Expert Interview	Create Frameworks	Pilot
Define Your Audience	Brainstorm	Define Success
Conversation Starters	Brainstorm Rules	Keep Iterating
Extremes and Mainstreams	Bundle Ideas	Create a Pitch
Immersion	Get Visual	Sustainable Revenue
Analogous Inspiration	Mash-Ups	Monitor and Evaluate
Card Sort	Design Principles	Keep Getting Feedback
Peers Observing Peers	Create a Concept	
Collage	Co-Creation Session	
Guided Tour	Gut Check	
Draw It	Determine What to Prototype	
Resource Flow	Storyboard	
	Role Playing	
	Rapid Prototyping	
	Business Model Canvas	
	Get Feedback	
	Integrate Feedback and Iterate	

fig. 36 Phases and tools of the 2nd version of the HCD Process (IDEO, 2015)

The models of the d.school (Hasso-Plattner Institute and Stanford University)

Another DT model, similar to IDEO's 3 I, but developed in an educational context, is the Design Thinking model of the d.school of the Hasso-Plattner-Institute at the University of Potsdam in Germany, an institution directly connected with Stanford University and IDEO. Nearly the same DT model is proposed by Stanford University themselves, with only a small difference in the first 2 phases [see fig. 37 and 38].

In these models, based also on process experience from IDEO, the design thinking process is visualised in five/six steps, which are in the Hasso Plattner Model connected by curved lines to indicate that each step is performed in iterative loops. According to Thoring & Müller (2011), in the first step of the model, Understand, existing information about the topic is gathered through secondary research.

The second stage, Observe, is based on a qualitative research approach that includes interviewing and observing techniques to collect insights about the users' needs. Through storytelling, the insights are shared among the group and subsequently synthesised into a visual framework called Point of View which reflects the user's perspective. In the Stanford version of the model, this phase is called Define. The stage of Ideation corresponds in both models completely with the Ideation phase of the 3 I model. The next two steps Prototype and Tests contain the same activities and considerations as the Implementation phase of the 3 I model.

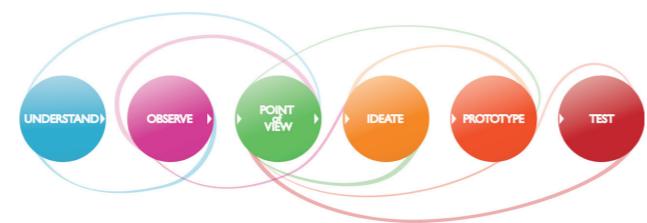


fig. 37 The Design Thinking Model of the Hasso-Plattner-Institute

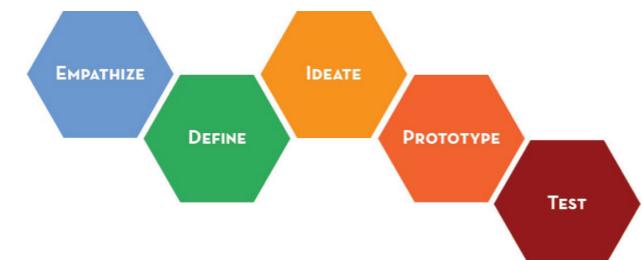


fig. 38 The Design Thinking Model of Stanford

Double Diamond model of the British Council

The Double Diamond design process model, developed at the Design Council in 2005, is graphically based on a simple diagram describing the divergent and convergent stages of the design process, which gives the model the form of a double diamond (<http://www.designcouncil.org.uk/about-design/How-designers-work/The-design-process/>, 03.05.2015). The model is also called 4 D model because the name of each phase starts with a 'D': Discover, Define, Develop and Deliver. What differentiates this model from the one of 3 I's or the HCD is the visual mapping of the divergent and convergent stages of the design process, characteristic for design thinking.

The first quarter of the Double Diamond represents the initial divergent part of the project, the Discovery phase, in which the designer is searching for new opportunities, new markets, new information, new trends, and new insights. The second quarter, which closes the first Diamond, marks the Definition stage, a kind of filter where the first insights are reviewed, selected and discarded. The Define stage also covers the initial development of project ideas, in which the designer must engage with the wider context of the identified opportunity. The key activities during the definition phase are project development, project management and corporate sign-off. The third quarter of the Double Diamond represents the period of Development. As in the Develop stage the project has been taken through a corporate and financial sign-off, we find ourselves again in a divergent period. Design-led solutions are developed, iterated and tested within the company by multi-disciplinary teams and under the use of DT tools such as brainstorming, sketches, scenarios, renderings or prototypes. In the last phase of the 4 D model, the convergent Deliver stage, the final concept is taken through final testing, signed-off, produced and launched. Every phase of the Double Diamond design process is much more detailed and complex than can be explained here, and this is of course true for all the other models presented in this chapter.

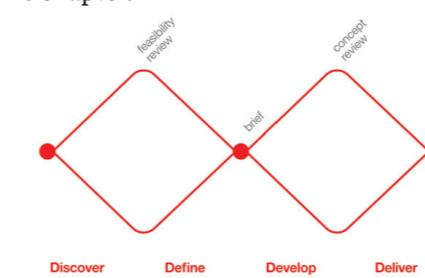


fig. 39 The Double Diamond design process model, developed by the British Design Council.

DT toolkit for Educators

Until now (2015) the only existing DT toolkit for Educators was also designed by IDEO in collaboration with the Riverdale School:

Riverdale & IDEO (2012). *Design Thinking for Educators*. 2nd Edition. Available in <http://www.designthinkingforeducators.com/toolkit/> (03/10/2015).

Riverdale and IDEO's DT for Educators is a complete working guide with very detailed specifications for each phase of the process. It is composed of 5 phases: Discovery, Interpretation, Ideation, Experimentation and Evolution, oscillating between divergent and convergent thinking modes. It's also accompanied by a workbook, so that it can be easily applied by educators. Although it was primarily designed with the Riverdale School in mind, it also sheds some light on issues and strategies regarding HEI education. The toolkit introduces and motivates the discussion around Design Thinking in education and the particular DT mindset which is described here also as human-centred, collaborative, optimistic and experimental. Because this is a toolkit for those that aren't familiar with the Design Thinking process, the guide starts by presenting a number of questions and examples of needs identified in the context of education, starting from the actual needs and opportunities taken from real testimonials.

In the first pages of this toolkit, many problems in the context of education are given, searching for new perspectives, new tools and new approaches. After this presentation it is intended for educators, presenting a set of solutions and benefits Design Thinking can offer, followed by a definition of what Design Thinking is, what are its main characteristics, where can it be applied, how it is practiced and explaining the design process. It ends with some suggestions for an appropriate mindset on the part of educators.

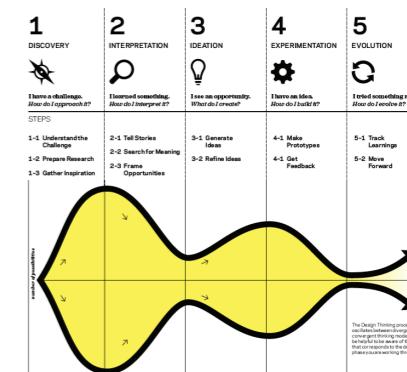


fig. 40 Phases and tools of the DT for Educators toolkit (Riverdale & IDEO, 2012: 15)

Conclusion about the DT toolkits

The first well-known model, the 3 I model, is based on an acronym, which presented a big advantage: the three phases are easy to remember and each phase has an associated space of action. The weak point of this model, as Tschimmel (2012) pointed out, are the terms used for the two first phases, Inspiration and Ideation. Because of the etymological significance, these terms can lead to wrong interpretations: 'Inspiration' leads to the false impression of easily formed ideas and an artistic approach of the creative process. 'Ideation' etymologically limits the second phase to idea generation, excluding the material and technical contributions to new ideas and concepts.

In comparison with the 3 I model, IDEO's HCD model is a lot more complex and comprehensive, as it comes with a practical toolkit. Furthermore, the double meaning of the acronym HCD happily embraces the human centred design approach and the 3 phases of the creative process in the first edition of the toolkit. The etymological associations of Hear, Create and Deliver are much more appropriate to describe the creative design thinking process than the more abstract terms of Inspiration, Ideation and Implementation. Nevertheless, IDEO resumed these terms to divide the design process in 3 phases in the new version of the HCD model. This new HCD design toolkit is clearly a fusion of the first HCD model with the 3 I model.

Comparing the space-phase sequences of all above presented models, despite the different numbers of process phases, we can affirm that they are very similar [compare fig. 12], DT for Educators being the model with the more different division of the process. The iteration principle of Design Thinking is presented in this model through the last phase, called Evolution. Better than all the other models, the DT model from the Hasso-Plattner Institute [fig. 37] shows that the stages of a design process are not always undertaken sequentially, but that projects may loop back to earlier phases. On the other hand, the Stanford DT model and the Double Diamond model are characterised by a visual description of the divergent and convergent stages of the design process.

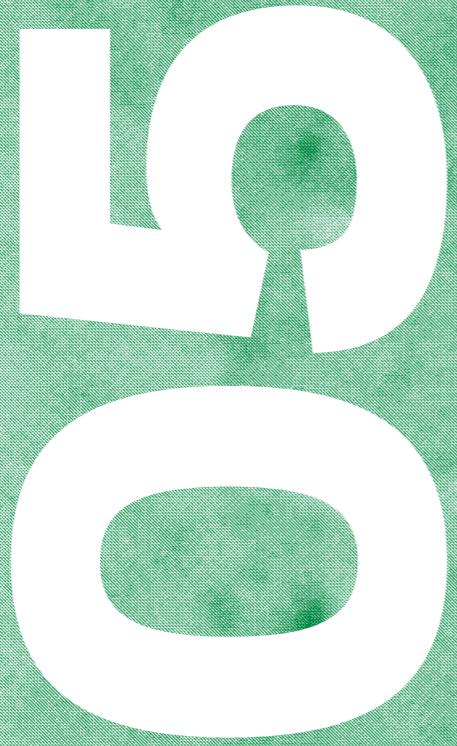
Based on the experience of IDEO with social innovation projects, the 3 I and HCD models have in common the human-centred design approach: DT is seen as a process that contributes to innovation through learning with people to meet their needs in their social context. The same can be said about the approach in the DT for Educators toolkit.

With the exception of the 3 I model and the DT model from Hasso Plattner, all models have a complementary toolkit where the process phases and the different DT techniques are explained and contextualised through practical examples. *Design Thinking for Educators* refers in its workbook to the duration and degree of difficulty of each technique, and classifies the techniques in 'reflective', 'interactive' or 'hands-on', identifying the number of participants, advantages of use and some mindset tips.

The recent HCD design kit starts with a brief introduction to the designer mindset as a problem solver. Giving particular importance to the mindset, several testimonies are given: David Kelley (Creative Confidence), Krista Donaldson (Make it), Tim Brown (Learn from Failure), etc. Regarding the tools, the HCD field guide offers 57 methods, a comprehensive set of exercises and activities that lead the design challenge towards the "getting into the market" stage. It assumes that some tools will be used several times and some not, according to the situation and work. A certain flexibility for the use of the DT tools are given in every toolkit, calling attention to the fact that the process is not linear and some tools are able to be applied in more than one phase of the process. All analysed toolkits are very visual, each technique/method has its own pictogram and a brief introduction followed by a series of steps for its implementation. The DT for Educators toolkit is extremely detailed, but easy to read, using images, topics, helpful tips, and little notes which provide an outline to the whole process.

In a final observation, the utility of the DT for Educators model has to be highlighted, but also all the other presented DT models and toolkits can give an important contribution to the development of the D-Think toolkit.





Design Thinking applied in HEI and VET Education

Design Thinking applied in HEI and VET Education

Design Thinking applied in HEI Education

The need for educational reform has led to much research documenting the value of experiential learning and creative problem solving to increase relevance and motivation in learning. According to Norman (2000), Design, which may be succinctly defined as purposeful thought and action, can serve as a framework and catalyst for teaching and learning strategies that promote innovative thinking, cooperative teamwork, and authentic performance assessment. The workbook *Design Thinking for Educators* (Riverdale & IDEO, 2011) with its case study, mindset and toolkit, is the best example for this affirmation.

According to the results of a delphi analysis, Park and Kim (2013) came to the conclusion that Design Thinking can be seen as the foundation of multidisciplinary education. Taajamaa et al. (2013) presented in their paper "Dancing with Ambiguity – Design Thinking in Interdisciplinary Engineering Education" two master level project courses that use design thinking processes and problem-based learning as the main

educational approach. One of the courses has been under development since 1996 and another one was launched during 2012. Both are interdisciplinary and multicultural by nature and have a liberally-defined and open-ended real-life problem setting. In their paper they examine the two courses impact on the learning results concerning working life skills such as communication skills, teamwork, design thinking, problem solving and an entrepreneurial mindset. They also seek to understand how these findings relate to design thinking and problem-based learning theories. Based on semi-structured interviews, journal reviews and surveys, they conclude that in both course structures, the students go through a significant learning process that involves learning from the areas of: 1. Communications, team dynamics, cross-cultural, and multiple disciplinarity; 2. Self-discovery, personal growth and team based group work; 3. Design process, prototyping, testing and decision-making; 4. Attitude for failing, entrepreneurship. However, this research is limited to the student and teacher perspective of the learning results. Industry, university administration

and other stakeholder opinions and perspectives were not within the scope of this paper.

In the following matrix the thinking process elements of Traditional Educators are compared with the mindset of a Design Thinking Educator.

CHARACTERISTICS OF A DESIGN THINKING EDUCATOR	CHARACTERISTICS OF A TRADITIONAL EDUCATOR
abductive and inventive	analytical, deductive and inductive
problem and design-based	discipline based
without walls, different social forms	classroom centric, tables in group position
principally collaborative	principally individual focused
failure is a part of the process	looking for "correct" answers
comfortable with ambiguity and uncertainty	lead by organizing and planning
empathic and human-driven, deep understanding of learners needs and dreams	student-driven, deep understanding about what students have to learn according the curricula
mainly visual, use of sketching and prototyping tools	mainly verbal, use of diagrams and tables

fig. 41 How could Educators think like Designers?

Trends in Entrepreneurship Education and Training

In our research about trends in entrepreneurship education and training we came to the conclusion that the majority of the identified studies were related to entrepreneurship education in HEI and very few publications were found regarding the specific context of training. An important aspect to consider in entrepreneurship education is its practical application in society, development of the economy and general business activity. Teaching entrepreneurship in HEI is particularly important because it is also in the entrepreneurial environment that high technology is being developed. It is the perfect nesting ground for the birth of new successful ventures. The transfer of knowledge to the economy is also of great importance for universities all over the world. The University of Cambridge, for example, has been exceptionally successful in supporting entrepreneurship clusters and providing the means for its communication with economic agents (Hyclak & Barakat, 2010). The creation of successful start-ups is a fact that supports this. Entrepreneurship education is needed to empower and promote the success of new businesses and innovation. In the University of Cambridge programmes have been designed to inspire an entrepreneurship mindset in science and engineering students.

One trend identified in Entrepreneurship teaching and learning is the new role taken by teachers, as facilitators or coaches. Students develop an entrepreneurial mindset with the help of a teacher/facilitator who orients the learning process, using the resources made available by the HEI. The teacher is the catalyst, so he has to be well trained, with the right skills and attitudes (ECORYS UK, 2011). Entrepreneurship education is essential in the correct and successful development of the entrepreneur persona in students, as it is to acquire the needed competencies.

The process of entrepreneurial learning is rather complex. According to Politis (2005), entrepreneurial learning is an experiential process where the entrepreneurs personal experience is transformed into knowledge, which in turn can be used to improve the further choice of new experiences. Some researchers reflect on the study of the suitability of different pedagogical approaches in entrepreneurship education. Teaching entrepreneurship demands different kinds of teaching and training to achieve and develop the full entrepreneur potential in students and trainees. Different pedagogic approaches may be combined to achieve the best results. Ripollés (2011) points out the need to balance training in business knowledge with training in the behaviour skills as paramount for an entrepreneur.

The use of bootcamp models for training is becoming increasingly common, not only in HEI, but especially with big companies. Recent research claims that the learning context can be one of the most determinant factors in the success of the learning process. Taking people out of their usual learning/training context and training in entrepreneurship campsites can promote excellent results (Bager, 2011). In this context, the educator is viewed as a facilitator in the knowledge creation processes instead of a knowledge provider.

Von Kortzfleisch, Zerwas, & Mokanis (2013) identify the unexplored possibilities of applying the DT methodology in the context of entrepreneurship education. They propose the concept of Entrepreneurial Design Thinking® as a new method for teaching entrepreneurship in higher education. According to the study, the characteristics of Entrepreneurial Design Thinking® can enhance entrepreneurship education by supporting the respective action fields of entrepreneurial learning. Based on the body of knowledge covering

design science, design thinking and entrepreneurship, the authors define Entrepreneurial Design Thinking® as a team diversity based approach, for treating user-centred problems as entrepreneurial opportunities within an iterative process supported by the use of creativity fostering tools and environments. A model for Entrepreneurial Design Thinking® is introduced, and its main characteristics and the implications for entrepreneurship education are presented. It is left as a suggestion that this methodology may increase the likelihood of successful start-ups with university origins.

The article from Kortzfleisch et al. was considered by the ESAD research team as one of the high quality papers used in desk research. Another important publication which supports the use of Design Thinking in entrepreneurship education is the article "Action-based learning for Millennials: Using Design Thinking to improve Entrepreneurship Education" (Zupan, Nabergoj, Stritar & Drnovšek, 2014). Zupan et al. describe an approach to teaching entrepreneurship courses in HEI using the Design Thinking methodology. They identify several advantages of introducing Design Thinking in the curriculum of entrepreneurship courses. The study compares what entrepreneurs and designers do, concluding that there are numerous similarities. The authors conclude that Design Thinking can be successfully used as a methodology for teaching entrepreneurship and contribute to improve student's entrepreneurial skills.

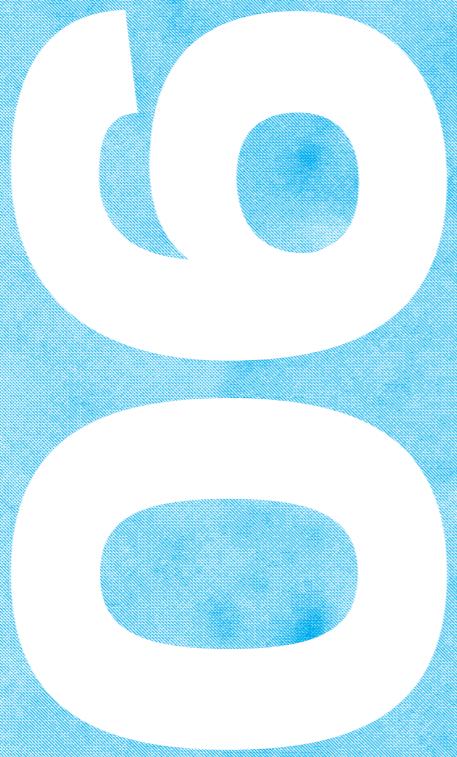
Design Thinking applied in Training & VET Education

When we compare the quantified results obtained in the literature review in the search for relevant articles about Design Thinking applied in Education with the ones obtained in the search for Design Thinking applied in Training / VET Education, a very different reality can be observed. In the conducted research very few peer-reviewed publications were found about Design Thinking applied in Training. In total, five publications with interest to this project were identified. After verification, it was clear that even those publications applied the word Training as a synonym for the development of skills and competencies in Design Thinking, and thus not directly addressing it as a methodology applied in vocational education training. In the conducted research, namely in the realised interviews, trainers expressed the need to improve the training/learning process suggesting the use of new methodologies. Our research indicates that Design Thinking has the potential of being a successful tool in this context, but it is not yet being applied. Our research didn't find any case studies about that subject reported in peer-reviewed publications. This shows that there is an open field of study to explore in future research, studying the use of the Design Thinking methodology in the specific Training / VET Education context.

The Future of Design Thinking in Education

Despite the success the Design Thinking methodology has at the moment in the professional universe of innovation and also in education for creative thinking in general, some authors are moving to other conceptual frameworks, such as Nussbaum (2011) who developed the concept of Creative Intelligence (Nussbaum 2013). In his book *Creative Intelligence*, Nussbaum identifies and explores creative intelligence as a new form of cultural literacy and as a powerful method for problem-solving and driving innovation. A similar approach we can find in the new way David and Tom Kelley (2013), the Founders of IDEO, are promoting design thinking as a way to get creative confidence. They based their approach on research studies such as the one realised by Rauth et al. (2010) or Jobst et al. (2012). Rauth et al. describe in their paper "Design Thinking: An Educational Model towards Creative Confidence", design thinking as a learning model towards creative confidence. Their study draws attention to the question of how creativity can be mediated via design education. Since the institutions they belong to focus on teaching design thinking, they questioned themselves what the experts in education believe they achieve with their lessons, and how they support students in developing a capability of thinking and acting creatively. In their empirical research, Rauth et al. find that there are different levels of creative knowledge, skills and mindsets that can be achieved by design thinking education, culminating in a capability which they call 'creative confidence'. Building on these results they demonstrate how design education contributes to both the development and understanding of creativity.

Whatever the upcoming concepts in the next years may be, Design Thinking as a mindset of creative thinking, focused on empathy with a problem context and users, will continue to give its contribution to innovation in organisations and education, as it offers systemised creative process models and tools which stimulate the evolution of our artificial world.



Conclusions of the Research Phase

Conclusions of the Research Phase

Although at this point of the D-Think project, it is not possible to fully answer the initial research questions of this research project, the first insights and directions are given in the following.

1. What is DT and why it is important to education?

After a change of paradigm, Design Thinking is seen today, in an interdisciplinary approach, as a method and a process for investigating ill-defined and wicked problems, acquiring information, analysing knowledge, deepening empathy, experimenting new perspectives and ideas, visualising and prototyping new concepts, always focusing on results. Design Thinking is essentially human-centred, multidisciplinary and collaborative, optimistic and experimental. For these reasons it is suitable to be applied in education and training.

- **Human-centred** because it begins with the understanding of human needs and motivations, educators has to develop empathy to successfully rethink the educational system and learning methodologies.

- **Multidisciplinary and collaborative**, because in order to solve problems and to get better and innovative solutions, Design Thinking as a design process engages different people with specific knowledge

and with collaborative roles in the development of a project. For example: people who work at, with and in Higher education schools. Design Thinking invites experts and users to find the best solutions. This can also happen at schools that will benefit from multiple perspectives and the creativity of others to find new educational solutions.

- **Optimistic** because it's believed that anyone, teachers and learners included, can create new solutions to solve a problem regardless of size, time and available budget.

- **Experimental** because Design Thinking is based on the belief that failures are an important input in the iterative process of learning from mistakes. In Design Thinking early tests are conducted with the objective to fail sooner, and learn from failures in order to find better solutions without spending too much money. It's a "learning by doing" process, where new ideas are based on a looped process of learning based on acquired feedback. In education, the idea of perfection persists with teachers, although it's required for them to experiment with students, to find new insights and new possibilities. Design Thinking is about believing that everyone can make a difference by transforming problems and difficult challenges into opportunities for change and improvement.

2. What is the level of knowledge in education about DT?

In the phase of Empathy, observing and listening to many educators and trainers, the research group came to the conclusion that more than half of the educators and trainers knew nothing at all or only very little about Design Thinking and were not aware of any techniques or methods, including those applied in the teaching context. It is important to point out that in fields such as Psychology and Educational Sciences, some work has been done to improve the education in HEI. Analysing those novel methods and the results after application, it became clear that, although those methods do not belong specifically to a Design Thinking model, they are quite similar with Design Thinking principles and approaches.

Educators and trainers do not associate Design Thinking as a method for innovation or learning. Design Thinking is seen as particular to the field of Product or Graphic Design. However, after a short introduction to the concept and the potential of DT applied in education, all of them manifested interest in this new methodology and were curious to know more about it.

3. What is the role of DT in education and training, and how is it transferable?

Design Thinking is an attitude, a model to structure and focus a design process. It can be used in education in the same way that it has been applied in regular design processes of products and service systems. It can be applied in education and training the same way as it is used in the field of management, or in any other field, wherever one needs the creative development of processes, strategies and programmes.

It is the focus on empathy with the user which makes the application of DT interesting. Empathy is what is needed to shape education and training according to the needs and motivation of individual learners and educators. Early experiments with the use of Design Thinking in education seemed to prove effective. Emerging trends in education are interdisciplinary study methods, problem based learning, student/trainee centred approach, team based learning, experimental learning, and the changing role of the teacher/trainer as a facilitator of a process.

All of these are very similar to what is the base of a Design Thinking approach: multi-disciplinarity, creative problem solving, human-centredness, collaboration, experimentation and the need for a process

facilitator. It can therefore be acknowledged that Design Thinking can be used to uphold any challenge in education, such as improving the curriculum, spaces, teaching and learning processes and tools, as well as shaping educational systems.

To transfer Design Thinking methodologies to the field of education, it's important for teachers to connect with their students and understand what are their interests outside the context of the school. A deep understanding of personal interests is necessary to foster motivation. This can be done by relating educational content to their personal interests. How can students be inspired so that they're capable of finding knowledge in unknown issues? Spaces need to be re-thought so that teachers and students can feel motivated, enthusiastic and comfortable, in order for collaboration to occur. Schools already have their processes and tools, but they can be redesigned. Not all people can contribute with new ideas in the current system, but they could for the new one, like connecting with the community reinforcing external relations.

4. Which kind of DT tools are appropriate in teaching and learning processes?

As stated before, the framework of the new toolkit is based on the Evolution 6² DT model with the full set of 36 methods and tools. During the experimentation phase, this original set of tools was complemented with other tools as described in the literature about Design Thinking and Design Methodology. Those tools were selected using a modified goal orientated brainstorming session. This generated a first broad selection of tools based on a set of activities which were considered relevant for each of the six phases of a development process based on the Evolution 6² model.

Those activities were selected based on the perception of a generic design process, independently if it was going to be used for the development of teaching strategies, active learning planning or the simple design of more adequate interactive classrooms. Gut feeling, professional experience and references from other design thinking toolkits were plausible input for the structuring and organisation of this first draft of the toolkit. Therefore, at this stage of the research project this set of tools should be considered adequate in teaching and learning processes. But, since this project itself is based on a DT model and is as such a human-centred design process, this original set of tools has to be considered as the initial input for

an iterative design process of make-test-analyse-re-design. Which kind of DT tools are appropriated in teaching and learning cannot be fully answered at this stage, but should be the conclusion of a process of refined selection through experimental application. Furthermore, the present set of tools is too extensive and some of the tools have to be polished and adapted to the specific needs for shaping learning and teaching processes. In the following 2 years of the D-Think project, this research question will be answered with the participation of all European partners under the coordination of the Finnish partner VAMK, represented by Tanja Oraviita.

5. How can the new DT toolkit help educators to learn how to improve the learning competences and capabilities of their learners?

In traditional education, information and knowledge transfer were all focused on one central figure, the teacher. Learning was a rather passive process and learning competences and capabilities was something each one had to find out for himself. However, at the beginning of the 20th century and through constructivist influences on education philosophy, responsibility for the learning process shifted towards the learner. It was claimed that a more active attitude to learning would improve the process and consolidate the knowledge gained much more effectively. Furthermore, each learner was considered unique and a general learning process fit for all was considered very unproductive. However, changing existing educational programs and reshaping them for personal improvement of each individual learner proves difficult.

Educators do not have a formal design education and are not trained in the creative development of learning programs. It is, therefore, that a DT model with its emphases on empathy and a human centred approach could prove to be a valuable aid in doing just that, providing an educator with the necessary guidelines and support to develop strategies and programmes which the goal of improving learning competences and capabilities. These would target each one of his learners individually, finding the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyse and fit solutions to the context.

Design Thinking can also create and improve a positive classroom experience, however no one single tool or method can be pointed out as being able by itself to create positive experiences in the classroom. This

is not what those tools were designed for. If positive classroom experiences are the goal of a planned design process, it is the careful structuring of the process based on the application of a selective sequence of tools and methods which will determine the outcome of the design process. It is the application of the outcome of this process which might provide positive classroom experiences, be it either in theory based or practice based classes. It is one of the main objectives of the toolkit, which is the subject of this research process, to be able to provide the methodological guidelines to assist teachers and learners to develop strategies, processes or even objects which will support their quest for positive experiences. These experiences are the driving force and the motivational support for life-long learning.

6. Is the Evolution 6² model appropriate to be applied in our research process/learning process?

Research can be defined as a “studious inquiry or examination aimed at the discovery and interpretation of facts” (Merriam Webster, 2008: 1059). The goal of an exploratory research, such as the one which was conducted in this project, aims to clarify a given set of research questions. How this research is framed and structured depends on the topic, the final goal and the particular field or discipline. In this project the final goal was the exploration and clarification of the role of Design Thinking in education and training, getting empathy with the target group, and identifying new approaches of entrepreneurship learning which can be useful for the D-Think toolkit for Educators and the m-learning course.

The Evolution 6² model, developed by the head researcher of this project, had been proposed as a workable structure for this research process and as such was accepted. The Evolution 6² is a descriptive and generative model which can be used as a method to guide a design process. It includes quantitative and qualitative, primary and secondary research methods, connected with visual thinking and sense making tools. The Evolution 6², with the full set of 36 methods and tools, was used in this project to guide the exploratory research and structure the process through the application of a set of methods and tools. Visual tools such as matrices, visual boards, maps, etc, supported the primary research methods. The essentially visual nature of the outcome of most of the tools which were applied was most helpful to map the results and sup-

port the interpretation of sometimes quite complex information that had been collected. The visual presentation of results also provided the means for better communication between the different researchers not always present at the same instance. Furthermore, following the model helped to identify divergent and convergent moments of the process.

As Design Thinking is an iterative process, in the following phases of the D-Think project, specifically the development of the DT toolkit and the m-learning course, the process of the E6² model will continue, probably going back to the empathy phase by testing some of the identified DT tools with educators and trainers to get their feedback on it. As visually exposed in fig. 4, the research process of this DT project goes on 3 parallel channels, thus the guidance by a model as the Evolution 6² gives an important methodological support to an international research team working mostly at distance.

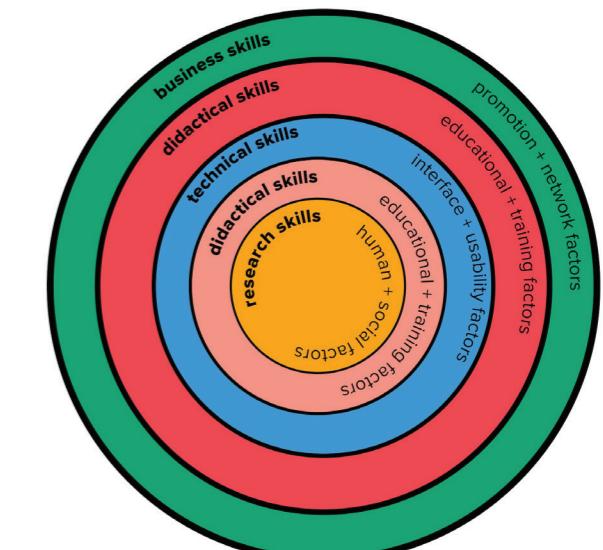


fig. 42 The D-Think Skill Diagram

conclusions of the research phase



fig. 43 Participants of the first partner meeting in Portugal

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* All the defined **High Quality Papers and Books** are marked in bold

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