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Aims and Scope

Educational Technology & Society is a quarterly journal published in January, April, July and October. *Educational Technology & Society* seeks academic articles on the issues affecting the developers of educational systems and educators who implement and manage such systems. The articles should discuss the perspectives of both communities and their relation to each other:

- Educators aim to use technology to enhance individual learning as well as to achieve widespread education and expect the technology to blend with their individual approach to instruction. However, most educators are not fully aware of the benefits that may be obtained by proactively harnessing the available technologies and how they might be able to influence further developments through systematic feedback and suggestions.
- Educational system developers and artificial intelligence (AI) researchers are sometimes unaware of the needs and requirements of typical teachers, with a possible exception of those in the computer science domain. In transferring the notion of a 'user' from the human-computer interaction studies and assigning it to the 'student', the educator's role as the 'implementer/ manager/ user' of the technology has been forgotten.

The aim of the journal is to help them better understand each other's role in the overall process of education and how they may support each other. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to *Educational Technology & Society* and three months thereafter.

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Foreword: Quality Research for Learning, Education, and Training

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Keywords
Quality management, quality standards, quality management for learning, education, training, evaluation

Introduction

Quality seems to be a complex concept, specifically in the field of learning, education, and training. The tradition of quality goes back to the ages of craftsmanship and to industrialization, when factories established post-production inspection departments. Several principles of Taylor's (1911) approach to process organization can still be found in today's quality approaches. The concepts of quality control (Juran, 1951) and total quality management (Deming, 1982) have been the main benchmarks in the evolution of quality management. Today, a variety of concepts and approaches are being discussed in the researchers' and practitioners' communities.

This special issue provides a comprehensive survey on concepts and approaches of quality for the field of learning, education, and training. It shall provide support to researchers and practitioners in improving quality in their organizations. This issue covers a broad range of both perspectives on and approaches to quality.

Pawlowski provides an introduction to quality and standards in the field of learning, education, and training. He states that quality cannot be seen as a fixed concept or methods, but that it must be adapted to the needs of organizations. The quality adaptation model provides a guideline on how to adapt the generic standard ISO/IEC 19796-1.

The learner's perspective is also the main focus of a paper by Alexander and Golja. They analyze instruments for quality, such as benchmarking and checklists. The presented approach shows how students' feedback and experiences can be used to develop institutional e-learning quality.

One main instrument for quality enhancement is evaluation. Deepwell shows how evaluation can be used as a participatory tool for quality enhancement within the implementation of e-learning programs. Nesbit and Leacock also use evaluation as an instrument to assure the quality of learning resources. Their framework focuses on different aspects of quality, such as content, motivation, accessibility, and interoperability.

Two papers in this issue present indicators that focus on the issue of how quality can be measured. Ellis and Calvo present a study comparing seven universities. They show minimum indicators as standards for learning management systems in blended learning settings. Yukselturk and Bulut present a study on predictors for students' success. Based on a study, they present factors that influence students' success.

S. J. H. Chen, Yang, Kinshuk, and N.-S. Chen present a specific quality approach for virtual learning communities. They show two perspectives: the identification of quality content and quality collaborators. The main aspect of this method is knowledge-sharing in communities.

The awareness of quality seems to be higher than the actors' competencies in this field. Ehlers develops the concept of quality literacy defining dimensions and competencies. Based on this model, he describes a participatory approach to quality development, focusing on negotiation and participation processes.

Finally, Chang-Barker presents a practical report on quality standards. Whereas the ISO/IEC standard focuses on processes, this paper focuses on the learner's view. The paper reports on tools for quality assurance: a learner's guide and the quality mark eQcheck.

This short introduction shows the diversity of views on quality in the research community. This issue shall help to define focus areas and show potential solutions for e-learning quality. However, new questions and research issues arise. Quality will still be an important issue for the e-learning research community in the coming years.

Acknowledgements

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Pawlowski, J. M. (2007). The Quality Adaptation Model: Adaptation and Adoption of the Quality Standard ISO/IEC 19796-1 for Learning, Education, and Training. *Educational Technology & Society*, 10 (2), 3-16.

The Quality Adaptation Model: Adaptation and Adoption of the Quality Standard ISO/IEC 19796-1 for Learning, Education, and Training

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ABSTRACT

In 2005, the new quality standard for learning, education, and training, ISO/IEC 19796-1, was published. Its purpose is to help educational organizations to develop quality systems and to improve the quality of their processes, products, and services. In this article, the standard is presented and compared to existing approaches, showing the methodology and its advantages for educational organizations. However, since the standard is a reference model, it has to be adapted to the needs and requirements of an organization. Hence, the main aspect is the adoption and implementation process: How can ISO/IEC 19796-1 successfully be implemented in educational organizations and support the variety of involved actors? To answer this question, the quality adaptation model identifies steps and instruments to bring the abstract standard into practice. The article closes with a case study evaluating the use and adequacy of the model.

Keywords

Quality standard, ISO/IEC 19796-1, Reference process model, Quality management for learning/education/training

Introduction

This article shows how to use and adapt the new quality standard for learning, education, and training, ISO/IEC 19796-1 (ISO/IEC, 2005), to improve the quality of processes, products, and services of an educational organization. The main objective is to show how actors in educational organizations can use this standard and organize the adoption process.

Generally, quality is an issue of increasing importance in educational organizations (Ehlers et al., 2005). However, there are currently no commonly accepted approaches (Kefalas et al., 2003). Therefore, many obstacles to implement and achieve quality can be found in practice. First of all, organizations have to choose an adequate approach from the variety of existing approaches that meet their needs and requirements. Secondly, successful implementation depends on overcoming typical barriers (Masters, 1996). The new quality standard ISO/IEC 19796-1 was developed to overcome those problems. However, implementing a standard in an educational organization is a complex task requiring competencies, commitment, and resources.

This article starts with a discussion of the state of e-learning quality. The standard ISO/IEC 19796-1 is described and analyzed with regard to its suitability for educational organizations. One main concern is the adaptation of an abstract standard to meet the needs and requirements of the users. For this purpose, we present the quality adaptation model (QAM), a concept for the adaptation, implementation, and use of this standard in educational organizations. The concept was analyzed and evaluated in different cases (CEN/ISSS, 2006b).

Quality approaches and standards for learning, education, and training

Quality in the field of learning, education, and training, and specifically e-learning, has become an issue of increasing importance in both researchers' and practitioners' communities. A variety of approaches has been developed and implemented in different sectors, such as higher education (Cruickshank, 2003), schools (Greenwood & Gaunt, 1994), in the e-learning sector (SRI, 2003), or the service industry in general (Yasin, Alavi, Kunt, & Zimmerer, 2004; Douglas & Fredendall, 2004). All approaches differ in various aspects, such as scope or methodology.

There is no common understanding about the terminology or the methodology of quality because quality can be seen from a variety of perspectives and dimensions. Ehlers (2004) states that quality is a multi-perspective construct. The main perspective is the terminology and the corresponding understanding of quality. The term quality is not defined and interpreted as common sense. A widely used definition by Juran (1951, 1992) is "fitness for purpose." Moreover, the International Organization for Standardization (2000) defines quality within the standard ISO 9000:2000 as the "ability of a set of inherent characteristics of a product, system, or process to fulfill requirements of customers and other interested parties." However, these definitions are far too generic to be applied in the field of e-learning. The specific requirements of e-learning environments, such as incorporating the complex roles in the educational process, are not taken into account.

From a second perspective, quality also depends on the scope and objectives. Various concepts have been developed for generic purposes, such as total quality management (Deming, 1982). Total quality management has also been applied to specific sectors and scopes, for example, information systems management (Cortada, 1995; Ravichandran, 2000), software development (Rai, Song, & Troutt, 1998; Gill, 2005), or higher education management (Cruickshank, 2003). Additionally, several concepts have been developed for highly specific purposes, such as metrics for data quality (Pipino, Lee, & Wang, 2002) or learners' and teachers' performance (Shaha, Lewis, O'Donnell, & Brown, 2004).

The last perspective deals with the focus and methodology of the quality approach. Dippe et al. (2001) give a rough distinction of the subject of quality assurance: processes, products, and competencies. Another distinction is the methodology distinguishing the type of quality approach, such as quality management, quality assurance, benchmarking, accreditation, or criteria catalogues (CEN/ISSS, 2006a).

As a conclusion of this exemplary review on varying perspectives of quality, I define quality in the following as "appropriately meeting the stakeholders' objectives and needs, which are the result of a transparent, participatory negotiation process within an organization." Moreover in the field of e-learning, quality is related to all processes, products, and services for learning, education, and training supported by the use of information and communication technologies.

Correspondingly, the definition of quality should be based on various attributes reflecting the above-mentioned different perspectives. To describe quality approaches in depth, the following attributes help to distinguish quality concepts:

- **Context and scope**: Intended context of the approach (for example, schools, higher education, vocational training). Which processes are covered (e.g., design, development, realization)?
- **Objectives**: What are the quality objectives that can be achieved by an approach? (Some examples are cost reduction, process consistency, learner satisfaction, and product reliability.)
- **Focus**: Does the quality approach focus on 1) organizations/processes, 2) products/services, or 3) competencies?
- **Perspective**: For which stakeholders and, correspondingly, from which perspective was a quality approach designed? (Developers, administrators, learners?)
- **Methodology**: Which methods and instruments are used? (Benchmarking, criteria catalogue, guidelines, information provision?)
- **Metrics**: Applied indicators and criteria to measure the success. (Some examples are drop-out rate, return on investment, learner satisfaction.)

The main problem for organizations is finding an adequate quality concept that meets their requirements and needs (CEN/ISSS, 2006a) with regard to the above-mentioned attributes. In principle, two general directions can be identified in the field of quality approaches for learning, education, and training: *Generic approaches* are not limited to one domain (such as educational organization or e-learning providers). They are adapted to the specific requirements in the domain. *Specific approaches* are quality approaches that deal with certain aspects of the domain of learning, education, and training, specifically e-learning.

Generic approaches such as ISO 9000 (International Organization for Standardization, 2000) or EFQM (2003) are widely used and well accepted in the field of quality management. However, the effort to adapt those approaches is very high. Usually an organization has no domain-specific guideline for providing descriptions of their educational processes. In spite of those difficulties, a variety of successful examples (e.g., Cruickshank, 2003; SRI, 2003) show that it is possible to use those standards in the context of learning, education, and training but that adapting these standards still requires a great deal of effort. To avoid the large adaptation efforts, specific approaches for the field of learning, education, and training have been developed. As already mentioned above, these approaches differ in scope and methodology, ranging from quality-management systems for education to content-development criteria or guidelines. Moreover, none of these approaches has a wide acceptance in Europe (Ehlers et al., 2005).

Finally, a variety of related approaches for a specific quality objective exist. These standards are used to assure quality for very specific aspects, such as data quality or interoperability. The following table summarizes the potential choices for educational organizations.

Table 1. Classification of quality approaches

Standards' Type	***Purpose***	***Examples***
Generic quality approaches	*Concepts for quality management or quality assurance, independent of the domain of usage*	*ISO 9000:2000 (International Organization for Standardization, 2000)* *EFQM (European Foundation for Quality Management, 2003)*
Specific quality approaches for learning, education, and training	*Quality management or quality assurance concepts for the field of learning, education, and training*	*BLA Quality Mark (British Learning Association, 2005)* *QAA Framework (Consortium for Excellence in Higher Education, 2001)* *Quality on the Line Benchmarks (Institute for Higher Education Policy, 2000)* *ASTD Quality Criteria, American Society for Training & Development (2001)*
Related approaches	*Manage or assure specific aspects of quality. For example, learning technology standards are used to assure interoperability as a specific quality objective*	*Learning Object Metadata IEEE Learning Technology Standards Committee (2002)* *Data Quality (Pipino et al., 2002; Pierce, 2004)*

In general, all quality approaches — generic, specific, and related approaches — can be helpful for educational organizations. However, several weaknesses exist: First of all, most standards and approaches are not comparable; only expert users are informed on scope and applicability for a certain context. Secondly, the adaptation efforts for generic standards are, in many cases, too high. Additionally, specific standards are usually not widely used and not well known in the community. Hence, the objective of transparency cannot be achieved by those standards and approaches. These more theoretical findings were approved by a study that is presented in the next section.

Quality standards in practice

Quality standards should serve the needs of users and their organizations. To identify those needs, a study was performed on the European level in 2004 (N = 1750) (Ehlers et al., 2005). The study's main goal was to identify the situation in which quality approaches and standards were used and to identify the needs of the different stakeholders. The study was aimed at educational organizations, such as content and service providers, higher education institutions, and e-learning users, using an online survey. Participation was on a voluntary basis. The study was not meant to be representative because stakeholders already aware of the issue of quality were slightly over-represented. However, the study aimed at identifying general trends and needs, and the results indicate important trends and developments in this field.

First, quality strategies were analyzed. Only 26% of the survey participants use external approaches (such as ISO 9000 or BLA Quality Mark), 35% use approaches that have been individually developed in their organization. In 24% of the cases, quality is not part of the organizational strategy, and 15% of the participants have no strategy at all.

The results on the individual level indicate a similar trend: More than half of the users (58%) answered that they have been actively involved in quality projects. There was a drastic gap between providers and users: 70% of e-learning providers indicated that they have experience in quality projects, whereas 67% of customers and users indicated that they have no experience. Additionally, a more differentiated view shows that 77% of decision makers have been involved in quality-related activities, but on the operative level, 66% have no such experience at all. This means that quality is usually limited to the management level and that, in most cases, it is not implemented on the operational level. Since quality is not achieved by management only, this gap leads to the conclusion that strategies that involve all stakeholders must be found. Additionally, a "quality gap" was identified: This means that many organizations and individuals are aware of the importance of quality, but in practice, no activities are implemented in either their organization or for their individual job.

In summary, these results show that many stakeholders are aware that quality is important for their organization and their individual tasks. Currently, however, there are no adequate instruments to fulfill the needs and requirements of organizations and individuals so that they can easily adopt quality approaches in their organization. The main question is how to harmonize existing quality approaches so users do not need to choose between a variety of approaches. How can we develop a harmonized quality approach that takes into account the various existing practices? Therefore, we need to provide quality approaches specifically for educational organizations. To support those approaches, two factors seem to be of crucial importance: tools for adaptation and adoption, and instruments to ensure a broad level of participation.

The quality standard for learning, education, and training: ISO/IEC 19796-1

In the following section, I shall analyze whether and how an international quality standard can fulfill the needs and requirements of educational organizations. Furthermore, I shall explain the use of this standard.

The new standard ISO/IEC 19796-1 provides a reference framework for the description of quality approaches (RFDQ) (ISO/IEC, 2005). Such a reference framework represents the interrelationship of the aspects mentioned above and gives an orientation as to which aspects should be covered and how solutions for these aspects can be found. Thus, the RFDQ could be applied as roadmap to consecutively design and implement an adequate solution. The standard is an instrument to develop quality in the field of e-learning. It consists of three parts:

- a description scheme for quality approaches
- a process model as a reference classification
- reference criteria for evaluation

The RFDG supports the development of quality profiles for organizations (such as objectives, methods, relations, and people involved). Quality profiles mean that the generic standard is tailored to the needs and requirements of an organization. It does not provide specific requirements or rules. Rather, it is a framework to guide actors through the process of quality development in the field of e-learning.

The **Description Model** is merely a scheme to describe quality approaches (such as guidelines, design guides, or requirements). It documents all quality concepts in a transparent way. It is based on the CEN/ISSS CWA 14644 (CEN/ISSS, 2003), which provides an analysis scheme for quality approaches. Each process can be described by this scheme:

Table 2. Description model for quality approaches of ISO/IEC 19796-1 (ISO/IEC, 2005)

Attribute	Description	Example
ID	Unique identifier	ID1234
Category	Main process	Course development
Process name	Process name	Method selection
Description	Description of the process	"Within this process the didactic concept and methods are evaluated and selected."
Relations	Relation to other processes	"Before the method selection a target group analysis must be performed." (Process 1.6)
Sub-processes/sub-aspects	Sub-processes/sub-aspects/tasks	Method identification Method alternatives Method prioritization
Objective	Objective of a process	Adequate selection of one or more didactic concepts according to learner preferences and learning styles
Method	Methodology for this process	Method selection shall be based on the target group taking into account their competencies and learning styles. Methods are selected based on the teachers' experience.
Result	Expected result of a process	Method specification Documents
Actors	Responsible/participating actors	Team didactical design, Project leader
Metrics/criteria	Evaluation and metrics for this process	Criteria catalogue 3.2.2–3.2.6
Standards	Standards used	DIN EN ISO 9241, LOM See *Method Guidelines Handbook*
Annotation/Example	Further information, examples of usage	The methods used should be documented and listed in the didactical best-practice collection.

The description model serves only as certain kind of information base to provide a harmonized scheme to describe quality approaches.

The process model is a guide to the different processes for developing learning scenarios. The process model includes the relevant processes within the life cycle of information and communication technology systems for learning, education, and training. The process model is divided in seven parts. Sub-processes are also included referencing to a classification of processes.

Table 3. Process model of ISO/IEC 19796-1

ID	Category	Description/ Sub-Processes
1	**Needs analysis**	**Identification and description of requirements, demands, and constraints of an educational project**
		1.1 Initiation 1.2 Stakeholder identification 1.3 Definition of objectives 1.4 Demand analysis
2	**Framework analysis**	**Identification of the framework and the context of an educational process**
		2.1 Analysis of the external context 2.2 Analysis of staff resources 2.3 Analysis of target groups 2.4 Analysis of the institutional and organizational context 2.5 Time and budget planning 2.6 Environment analysis
3	**Conception/design**	**Conception and design of an educational process**
		3.1 Learning objectives 3.2 Concept for contents 3.3 Didactical concept/methods 3.4 Roles and activities 3.5 Organizational concept 3.6 Technical concept 3.7 Concept for media and interaction design 3.8 Media concept 3.9 Communication concept 3.10 Concept for tests and evaluation 3.11 Concept for maintenance
4	**Development/production**	**Realization of concepts**
		4.1 Content realization 4.2 Design realization 4.3 Media realization 4.4 Technical realization 4.5 Maintenance
5	**Implementation**	**Description of the implementation of technological components**
		5.1 Testing of learning resources 5.2 Adaptation of learning resources 5.3 Activation of learning resources 5.4 Organization of use 5.5 Technical infrastructure
6	**Learning process**	**Realization and use of the learning process**
		6.1 Administration 6.2 Activities 6.3 Review of competency levels
7	**Evaluation/optimization**	**Description of the evaluation methods, principles, and procedures**
		7.1 Planning 7.2 Realization 7.3 Analysis 7.4 Optimization/Improvement

Finally, with regard to Table 2 and Table 3, ISO/IEC 19796-1 contains a list of reference criteria for the assessment of the quality of learning products. The catalogue contains functional as well as media and learning psychology-related reference criteria. Furthermore, it includes criteria related to data security and (specially marked) criteria related to national laws in the area of distance learning.

An analysis of the standard should clarify whether its intended objectives are fulfilled and the above-mentioned main concerns of quality practitioners are addressed. The main intent is harmonization: Whereas many organizations have adapted general standards such as ISO 9000:2000 or the EFMQ Excellence Model, there is no commonly accepted quality framework for the field of e-learning (Kefalas et al., 2003). The following table gives the main aspects of my analysis.

Generally, the ISO/IEC 19796-1 quality standard provides a harmonized approach to manage, assure, or assess quality. Furthermore, the existing variety of standards, quasi-standards, and related standards (see first section) can be modeled using ISO/IEC 19796-1. Therefore, the goal of harmonizing existing approaches is met. However, the harmonization has been done on an abstract level, with no recommendations or guidelines for quality management given. These guidelines have to be developed by the users themselves. Consequently, the ISO/IEC 19796-1 standard is a basic model or roadmap for educational organizations and has to be adapted to each organization's specific context. For this purpose, the quality adaptation model was developed.

Table 4. Analysis grid

Aspect	***Result***
Harmonization	*ISO/IEC 19796-1 can be seen as a first step to harmonizing existing approaches. It provides a general process model for ICT-supported learning, education, and training. The processes are specific to the domain; however, not all specific scenarios are covered. For, when a specific provider develops game-based learning, the processes have to be extended.*
Completeness	*The description model contains the main element of process modeling upon which all kinds of processes can be modeled. As a weakness, there are no pre-defined relations sequencing the processes.*
Methodology	*The standard is a meta-model that incorporates other standards and approaches. It is not clear from the document itself whether or not the standard needs to be extended and adapted.*
Support of stakeholders	*The model might support stakeholders who want to define their processes in a structured way. However, the standard does not contain detailed guidelines for how to use the model. Therefore, application scenarios showing the model's practical use should be developed.*
Flexibility	*The standard provides a basic adaptable and extensible framework. Processes can be extended. Since the standard does not contain a conformance statement, each extension would relate to the harmonization aspect. Therefore, the building of profiles by communities of practice can be recommended.*
Consistency with other standards	*The model includes the main aspects that are covered in other process-oriented standards (see first section). It can be used as a blueprint for processes that can then be used in a generic standard, such as ISO 9000.*

Adaptation and adoption of ISO/IEC 19796-1: The quality adaptation model

Below, the quality adaptation model (QAM) is presented. It consists of different phases and steps to bring quality approaches, specifically ISO/IEC 19796-1, into practice.

The standard itself is a reference model that can be applied in different scenarios. To illustrate the potential use, I will first present three corresponding application scenarios. Secondly, the reference model has to be adapted by launching activities to adopt the standard in an organization. This should lead to an organization-specific model that contains the adapted processes but also specific measures to establish a quality culture in an organization. The following figure summarizes the relationship of the models.

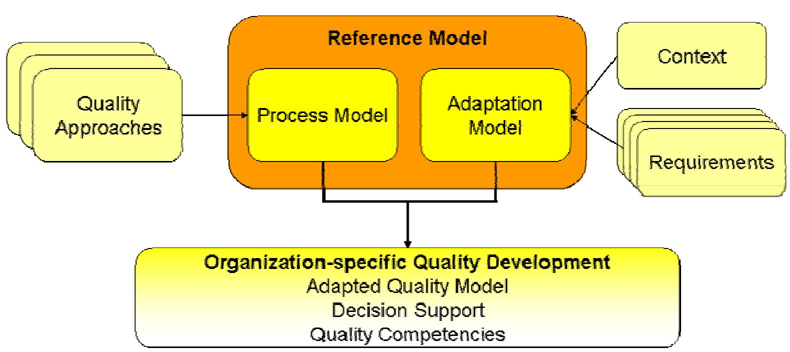

Figure 1. Relations of the Models

Application scenarios

There are several application scenarios in which to use the standard. The main application scenario is the organization-specific development of quality systems. The main objective of ISO/IEC 19796-1 is to provide a transparent description model to clearly describe and document quality management and quality assurance approaches. The description model provides processes to develop e-learning scenarios by specifying:

- quality objectives
- methods to ensure the quality
- actors involved in this process
- relations to other processes
- evaluation methods to assess the success of a process
- standards and references

Using the quality adaptation model, individual quality approaches can be designed, including aspects of approaches that apply to the context of usage. The adaptation process is described in detail in the next section.

As shown above, there is a variety of existing approaches that can be used for different objectives and purposes. Combining quality approaches is the second application scenario. The model provides clear terminology and description formats to assemble individual quality concepts from existing approaches. As an example, the management guideline principles of total quality management could be combined with specific content guidelines. By using the common terminology of ISO/IEC 19796-1, approaches can be combined and re-used in various (new) combinations.

The third application scenario is using the process model as a guideline. The second part of the ISO/IEC 19796-1 standard is a reference model containing all processes of the e-learning life cycle. It can be used as a guideline to develop quality concepts from the initial idea ("I would like to make my seminars more flexible.") through to optimization and improvement. Therefore, ISO/IEC 19796-1 can be used to support quality development for all actors.

The last scenario is using the evaluation field as a reference source. Typically, evaluations are not comparable because they do not use a common, consistent set of criteria. This is provided by the reference criteria as a reference source for evaluation criteria. Many organizations need to develop evaluation criteria for their education and training programs. ISO/IEC 19796-1 provides a collection of criteria to be used in evaluations for different purposes. Additionally, evaluations of products are more transparent and comparable because they relate to a standardized set of criteria.

The most important purpose is to support and develop quality in organizations. The next section shows how to implement quality development using ISO/IEC 19796-1.

The quality adaptation model

Adaptation in this context means that the reference model can only serve as a guideline upon which aspects should be based. Additionally, the model suggests steps to overcome the main barriers of quality management, such as the lack of management commitment, inadequate knowledge or understanding of TQM, the inability to change organizational culture, or the inadequate use of empowerment and teamwork (Masters, 1996).

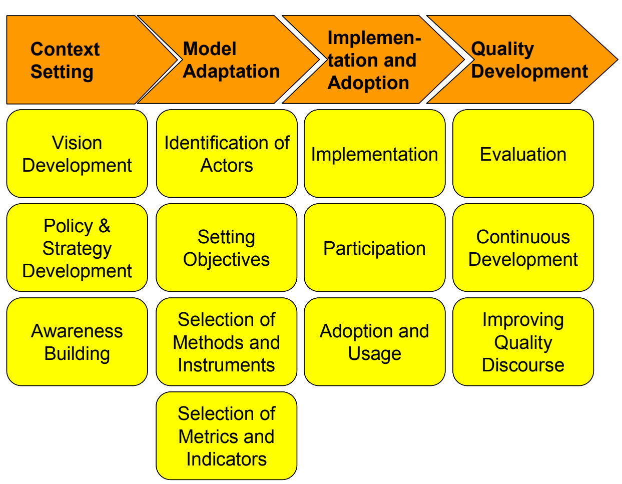

Figure 2. Phases of the Quality Adaptation Model

The quality adaptation model (QAM) follows a four-step process. These steps are not performed iteratively but are individually scheduled. Context setting covers all preparatory activities for the adaptation process. Model adaptation contains activities to implement the reference model based on the needs and requirements of an organization. Model implementation and adoption refers to the realization and the broad use of the quality system. Quality development means that quality systems should be continuously improved and further developed.

These phases contain several activities, which are explained in the following paragraphs.

Context setting: Providing the basis for quality development

This phase sets the context for quality development. It ensures that quality development is anchored and present in all parts of an organization.

An organization's long-term objectives, externally and internally, are contained in its vision, strategy, and policy statements. If an organization is committed to quality development, it should be mentioned in these statements. In most organizations, quality — and specifically, quality of e-learning — is not adequately represented. Therefore, the process to improve vision, strategies, and policies needs to be established (see Ittner & Larker, 1997).

The redefinition should not be only management's responsibility. The process, which actively sets new directions for organization, should be at least transparent to all staff members and include participants from all staff groups. As an example, the strategy/policy should explain how the quality of e-learning relates to the organization's core competencies and how it influences the main operations.

Directly related is the process of awareness raising. Quality development will not be successful if it is a top-down regulation. Quality development should be a part of everyday operations and related to all activities. Therefore, all members of an organization should be aware of quality and its meaning for their personal actions.

The outcome of this phase should include revised vision, strategy, and policy documents that show the organization's long-term view of quality and the consequences for all parts of the organization. All staff groups should be aware of and involved in this process.

Model adaptation: Individualizing ISO/IEC 19796-1

To establish the details of quality development in an educational organization, the reference model ISO/IEC 19796-1 can be used as a guideline.

First of all, the relevant actors for quality development should be identified. It is useful to involve actors of all departments and all staff groups in this process. Actors, acting as multipliers for their groups, should be involved. They should be fully committed to supporting the quality development process. The outcome of this phase is a list of actors responsible for quality. Usually, this also leads to changed job descriptions and agreements with these actors.

Secondly, the processes relevant for an organization should be identified. For example, for producers of learning media, only some sub-categories (such as design and production) might be relevant. As another example, for tutors only the learning processes would be relevant. Additionally, processes specific to an organization should be added.
The outcome of this phase is a comprehensive list of processes for the organization.

The main step of adaptation is setting quality objectives for each process. Quality objective means that each process should define how quality results can be achieved (e.g., "technical concept: the objective is to develop a clear, unambiguous specification of technologies that meet the users' needs and preferences."). The quality objectives for each process cannot be defined by just one individual; they are subject to a negotiation process and should be agreed upon in consensus with the relevant actors.

Based on the objectives, instruments and methods should be identified and selected. In this context these are concrete activities to achieve, assure, or assess quality for the given objectives. Examples of those instruments are benchmarking, assessments, or simply the use of questionnaires. Instruments to achieve the quality objective "24-hour availability of the support hotline" could be an assessment of the call center's staff, test calls, or technical monitoring. The selection of adequate instruments is crucial for the success of a quality system: these instruments need to be adequate for the quality objective, the effort should be small, and they should be well accepted by the participants. Therefore, it is useful to inform and train staff members in the use and interpretation of these instruments.

As an alternative, existing quality models can be incorporated into the reference model. As shown in the second application scenario in the section above, existing quality models (such as guidelines) should be analyzed. The analysis consists of defining, prioritizing, and selecting matching attributes, such as the context, objectives covered, and methodology (for a sample procedure of this selection process and the recommendation mechanism, see CEN/ISSS, 2006a; Manouselis & Sampson, 2004). By re-using existing approaches, the adaptation effort is decreased. However, this is still a future scenario, since not all providers of quality approaches use the description scheme of ISO/IEC 19796-1. Once this is achieved as a standard procedure, this re-use would enable the easy selection and incorporation of existing models.

Finally, usually connected to the choice of instruments and methods, metrics and indicators are chosen to assess and measure the success. Metrics should reflect the success of achieving a quality objective (for a survey on possible metrics see Hirata, 2006; Lytras, Doukidis, & Skagou, 2001). Typical metrics are, for example, drop-out rates and return on investment/education. These metrics need to be developed for each quality objective and must be evaluated continuously. In any case, there should also be a procedure on how to interpret metrics and which actions to take based on the interpretation.

The outcome of this phase is an organization's process model that includes quality objectives, responsible actors, methods/instruments, and metrics/indicators. By this description, the organization's actions to achieve quality are transparent, explicit, understandable, and repeatable. An example of a full process description is given below (Table 5).

Table 5. Sample process description

ID	Category	Process	Description	Relation
2.2	Framework analysis	Analysis of staff resources	Identification and description of actors, their qualifications and competencies, and availability	
Sub-processes/ sub-aspects		• Roles/functions • Competencies/formal qualifications • Availability of actors		
Objective		To clearly identify and correctly assess the roles/functions, competencies/qualifications, gaps, and availability of actors and users who will be involved in top management courses		
Method		Methods of empirical social/educational research (e.g., document analysis); consultation of specialists; staff profile analysis		
Result		• Description of roles functions of staff • Description of competencies/formal qualifications of staff • Description of availability of staff		
Actors		Project manager; HR experts, learners		
Metrics/Criteria		Categories 2, 3, 4 of reference quality criteria		
Standards		Project management and documentation guidelines; standards for social research		

Model implementation and adoption: Making the concepts work

In the initial adaptation process, usually only small groups of actors are involved. Therefore, an implementation strategy should be developed. This strategy should describe actions and activities that the quality system uses. Furthermore, it is of vital importance that all actors are aware and involved (see Thiagarajan & Zairi, 1997). This does not mean that all staff members should know the full quality system, but they should be aware of quality objectives for core and related processes that they are involved in. To establish participation, there should be opportunities for actors to influence, change, and improve quality objectives and methods. Usually, the first implementation is done in representative test groups. Therefore, further users need to be involved and become familiar with the quality concepts to systematically broaden the use of the quality system. The outcome of this phase should be an implementation plan that includes activities to broadly adapt the model.

Quality development: Improving the organization's performance

A quality system must be continuously evaluated, updated, and improved to be aligned to new developments in an educational organization. Therefore, the following steps are necessary. The quality system should be evaluated at least twice a year. Specifically, it should be evaluated if the quality system has led to overall improvements in the organization's performance. Furthermore, the adequacy of methods, instruments, and metrics need to be evaluated. Based on this evaluation, improvement actions should be taken, such as the change and refinement of the system's components. Again, for this phase broad commitment and participation are necessary to reflect the staff's opinions and attitudes toward the system. This should lead to a broad awareness and discussion on quality.

The outcome of this phase is an evaluation strategy, improvement concepts, and, most important, a broad discourse on quality. Specifically in the field of education, this will lead to a participatory process designing and developing learning scenarios.

The quality adaptation model in practice

To analyze the use and effects of the model in different cases, a study on the success factors of quality implementation projects was performed in European educational organizations within the European Standardization Body CEN/ISSS, coordinated by the author (CEN/ISSS, 2006b). The case study method was used to a) analyze the appropriateness in different contexts, and b) to observe potential improvements of the model. Case studies were used as the evaluation method to receive qualitative feedback from practical applications, covering a wide range of different contexts (from small content providers to larger higher education institutions). Therefore, it is necessary to include this range in the analysis. In the analysis, 15 educational organizations provided their input (CEN/ISSS, 2006b). In an initial competition, case studies were selected based on their performance and ability to show that their project was successful. The participating institutions reported on the adaptation process and identified success and failure factors. These factors were compared to the quality adaptation model and identified based on whether the phases of the model covered the main aspects of quality implementations. Specifically, the study focused on the results of the quality implementations and their success factors.

For each QAM phase, the main success and failure factors were analyzed. The following table (Table 6) indicates the results of the study, focusing on success factors for each phase. Additionally, the above-mentioned main barriers of Quality Management (Masters, 1996) were also found in the analysis. However, since the quality adaptation model addresses these obstacles by providing guidance to the users, concrete steps to overcome those aspects were identified and implemented. The following table shows the aspects and steps that were critical for the stakeholders.

Table 6. Success factors within the quality adaptation model

Phase	*Success factors*
	Context setting
Vision development	• *Quality should be integrated into the corporation's vision to express commitment internally and externally.* • *A clear vision will increase consumer confidence.* • *Strategies should be built, not on assumptions, but on verified concepts.* • *A quality vision can stimulate management to continuously improve quality.* • *A quality vision should contribute to innovation and competitive value.* • *The vision should be clearly communicated.* • *The vision should reflect the culture of the organization.*
Policy & strategy	• *Policy should incorporate quality.* • *The policy should clarify procedures and responsibilities.* • *Quality projects should be given strategic priority.* • *Quality should be seen as support for the innovation process.* • *Quality strategies should take external effects into account, such as trends, legislation, and developments within the society.*
Awareness raising	• *Communication is crucial from the very beginning of the quality project.* • *External experts should be involved to improve the credibility of the project.* • *The main stakeholder should be the customer.* • *Different methods, such as lobbying, workshops, conferences, publications, and tutorships, can support awareness building.* • *Quality should be related to the culture, way of thinking, and value systems of both the organization and the individual.* • *Communication through protocols/minutes/reports provides steady, continuous collection of*

	information.
	• *Specifically, the objectives of quality should be shared among staff.*
	• *Online training on quality and process approach should be provided.*
	• *Make people aware of their responsibility and benefits.*
	Model adaptation
Setting objectives	• *Quality objectives should be clearly defined.*
	• *As a first step, success factors for quality should be cooperatively defined.*
	• *The objectives should be negotiated, consumer-oriented, consensus-based, and inclusive of all e-learning elements, and should take into account views from inside and outside the organization.*
	• *Tools should be provided to decrease the manager's workload.*
	• *Quality should be defined for all user groups.*
	• *Objectives should be defined according to principles: best quality for clients, reduction of development time, increased profitability.*
Identifying actors	• *Key persons should be identified first.*
	• *Sufficient time should be allocated to the key persons.*
	• *Prototype groups (test users) should be the first to implement quality assurance.*
	• *Students or learners should play a main role in the quality process.*
	• *Operational groups and users should be involved in validation and steering committees.*
	• *Quality experts should support each group.*
	• *Collaboration tools (e.g., shared workspace) should be provided to support users.*
	• *Procedures to manage complaints should be in place.*
	• *Voluntary basis is not a strong enough motivation, people should be formally committed.*
Choosing methods	• *For each process, a quality assurance tool and a procedure should be defined.*
	• *Prototyping can be used as a supporting method for quality assurance for content providers.*
	• *Methods are not limited to classical QA methods, but should take into account other methods, such as marketing or controlling instruments.*
	• *Experts should provide adequate, validated methods.*
Choosing indicators	• *The main indicator should be customer satisfaction; for all quality activities, cost/effort can be seen as main indicators.*
	• *It is necessary to achieve the agreement of team members on every production measure.*
	• *Acceptance tests and benchmarking are useful for process as well as product measurement.*
	• *Data obtained from the field are essential because they allow reliance on facts and not on speculation.*
	• *Use, rather than merely store, the data obtained.*
	• *Quality should also be measured by people outside of the company.*
	Model implementation & adoption
Implementation	• *The main aspects of implementation are steering, communication, and commitment.*
	• *Guidance, help, and feedback should be provided in throughout the project.*
	• *Goodwill and vision is not sufficient to change people's mind — awareness building is crucial to reach organizational changes.*
	• *ICT tools should support management (measures and indicators).*
	• *Clear requirements and resulting tasks and responsibilities for QA should be defined.*
	• *Connect experts with non-experts, for example, QA-responsible person, management, technical people for implementation/development of tools.*
	• *Allowance of time for specific QA activities.*
	• *Benefits should be made clear at each stage.*
	• *Training should be started before the quality project to create quality knowledge for the staff.*
	• *Key factors of success are motivation, simplicity and readability of processes, and management involvement.*
Establishing participation	• *All actors are kept informed throughout the project, even when they don't play an active role in each phase.*
	• *Collaborative review and validation of the production should take place.*
	• *Actors should maintain ownership of their processes and of the quality of their work.*
	• *Forms should be avoided; innovative evaluation techniques should be used.*
	• *Steady, continuous information and regular feedback should be provided and encouraged.*
Broadening use	• *Prototype users should share their knowledge widely.*
	• *A variety of presentations and discussions should be given.*
	• *Risk factors should be addressed with appropriate protocols.*
	Quality development
Evaluation	• *Continuous discussions should be held to improve the final product.*
	• *Time is a critical factor for such a project and should be considered in evaluations.*
	• *Only an objective third party can provide valid, transparent, credible quality assurance that will be trusted by consumers.*
	• *Revision of the quality approach takes place throughout the project, with an emphasis on the clients' feedback.*
	• *Team reviews should be done regularly.*
	• *Collect users' feedback continuously.*
	• *Internal reviews should have priority over external audits to value the staff members' feedback.*
Model improvement	• *Quality implementation might become stale after a while — activities should be renewed regularly.*
	• *New techniques should be tried after the quality project reaches a stable stage.*
	• *Take into consideration every comment gathered in order to improve the model.*
	• *Definition of two criteria for model improvement: availability and added value, with a clear definition of how to measure the two.*

	• *Extension of QA by a formal approach and delivery standards.* • *Listen to all opinions for keeping the philosophy of continuous improvement, taking into account all mind-sets and interests of the stakeholders.* • *Proceed an "after review action" with all stakeholders.* • *Model and expand the approach to other contexts of use.* • *Improve and utilize structured tools.*
Quality discourse	• *Making people "quality aware" is a long process; hold training and discussion sessions regularly.* • *Communicate with peers on their achievements.* • *Involve other quality experts and benchmark results.* • *Discuss dissemination internally.*

The first main outcome of the case studies was that the completion of the quality adaptation model. This means that the phases cover all processes and aspects of quality management and assurance implementations. Along the phases, critical success factors in the practical use were identified. These success factors give further indications regarding how to close the gap between the importance of quality and its complex realization in practice in educational institutions. The most important success factor is also a focus of QAM: Similar to other large-scale change processes, participation and commitment seem to be crucial in all phases and must be established through various instruments, such as allocating resources, providing information, and allowing and valuing contributions of the stakeholders. Generally, it was shown that the model covers the most important processes for quality projects. By enriching the model with practical advice, users are supported in each phase of the quality project.

Conclusion

In this article, the appropriateness of existing quality standards and their use in practice in educational organizations were discussed. As a first assumption, it was identified that there is still a quality gap on the organizational and individual level: both management and individuals are aware of the importance of quality but there are no adequate approaches and adoption procedures. I analyzed how the quality standard ISO/IEC 19796-1 can contribute to change this situation and discussed whether this standard is an adequate basis for quality development in organizations. As a first analysis result, the theoretical analysis showed that this instrument can be useful for educational organizations; however, it is necessary to define procedures to adapt it in an organization and to adopt it on a broad base.

To implement a quality system in an educational organization, four main steps are necessary: context setting, model adaptation, model implementation/adoption, and quality development. Each step should be performed with a broad range of actors to raise awareness and consensus. To facilitate this process and to develop a quality system for an organization, the use of the ISO/IEC reference model for the description of quality approaches (QAM) was recommended and demonstrated.

Since the model is very generic, more research is necessary — especially to find specific solutions for different fields of usage (e.g., for schools). Additionally, research has been initiated to analyze the differences and adaptation requirements for different countries and regions to include cultural aspects. Finally, a variety of tools is being developed to support this process, such as the initial choice of a quality approach or the choice of quality instruments (Pawlowski, 2005). For the future, it can be expected that a variety of tools will be available to support this process and to integrate quality into a broad range of educational organizations.

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Using Students' Experiences to Derive Quality in an e-Learning System: An Institution's Perspective

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ABSTRACT

Higher education institutions undertake a range of approaches to evaluating and making judgments about the quality of their e-learning provision. This paper begins by exploring benchmarking as one current strategy in common use in universities to identify and implement quality practices: from the use of checklists (for example, of best practices and standards) to a more contemporary dynamic systems approach involving continuous cycles of feedback and improvement centred around the learners' experiences of e-learning. These practices are influenced by the teachers' design of e-learning and emerging technologies as well as by the institutional and societal contexts in which both learners and teachers operate. We give an account of two major evaluation studies at the University of Technology, Sydney (UTS), utilising a systems approach to investigate the consequences of e-learning, and we inquire into the value of this particular institutional approach for deriving e-learning quality. We use selections from the large dataset to describe and analyse students' and teaching staff's experiences of an e-learning system (LMS) over a two-year period. Our findings reveal that learners' experiences warrant consideration in shaping future e-learning developments at UTS, and that students value e-learning in facilitating their access to education for making choices about their learning and for enabling engagement in collaborative and interactive learning activities, while they also recognise the current constraints on e-learning imposed by the developers of LMS technologies.

Keywords

E-learning quality, Benchmarking, Complex dynamic systems, Learning Management Systems (LMS)

Introduction

Many governments and organisations in various countries are developing ways of measuring and producing guidelines for e-learning quality in higher education. For example:

- UNESCO/OECD (2005) recognise e-learning in their guidelines on quality provision in cross-border higher education;
- Lee, Thurab-Nkhosi, and Giannini-Gachago (2005) worked collaboratively across two countries to develop a quality assurance tool for e-learning;
- KeKang, Hai, Chun, and Bin (2005) developed an authoritative index system of quality assurance for web-based curricula, teaching processes, and the supporting service system;
- Weir, Kulski, and Wright (2005) explore the extent to which Australian frameworks and strategies for quality assurance ensure online provision of high-quality transnational educational programs.

Other educational institutions are adopting approaches that entail checklists (for example, of best practices and standards), self-assessment kits, matrices, and benchmarks to evaluate the quality of courses offered in an online mode and the state of e-learning in higher education (for example, ACODE Benchmarking Project in Australia). So, to explore such approaches (as well as emerging ones) and in response to the current wide use of "benchmarking" as a way of assessing quality in higher education (Bridgland & Goodacre, 2005; Ellis & Moore, 2006), we begin by probing into what might constitute benchmarking and describe some recent institutional applications of these variations on benchmarking for making judgments about the quality of e-learning in higher education.

A selective review of the literature describes benchmarking as:

- **A process that uses "a permanent reference point against which levels can be compared and measured"** (Buss, 2001). In the United Kingdom, the National Learning Network (NLN) makes available a self-assessment kit to facilitate classification of universities according to the extent to which information and learning technologies (ILT) have impacted upon them. In order to measure the degree to which ILT has been embedded into teaching and learning, and to identify priorities for development, institutions review their current state of maturation on 14 indicators, including strategic management, learning resources management, learner IT skills, and record keeping.
- **A process through which "practices are analysed to provide a standard measurement ('benchmark') of effective performance within an organisation (e.g., a university)"** (Higher Education Academy, 2006).

The most notable work in the United States appears to be the *Quality on the Line* report (IHEP, 2000) prepared by The Institute for Higher Education Policy in collaboration with National Education Association and Blackboard. From a review of the distance education literature, the report identifies 45 initial areas of best practices from which 24 benchmarks deemed essential to ensuring high-quality distance learning are assembled. These benchmarks are categorised under seven headings: Institutional Support, Course Development, Teaching/Learning Process, Course Structure, Student Support, Faculty Support, Evaluation, and Assessment.

- **A process of "identifying, learning, adapting, and measuring outstanding practices and processes from any organisation/public entity to improve performance"** (European Institute for E-Learning, 2004). In another example taken from the UK context, the Higher Education Academy and the Joint Information Systems Committee (JISC) are collaborating to lead a UK-wide higher education e-learning benchmarking exercise with a pilot that commenced in January 2006. Though not limited to "outstanding practices and processes," the current focus of the exercise appears to be on learning about how different universities are embedding different aspects of e-learning into institutional policy and practice, and to provide institutions with quantitative metrics and qualitative descriptors on which to reflect, share experiences, and make informed plans for future development.
- **A process of "self-evaluation and self-improvement"** (Jackson, 2001), **of "improving ourselves by learning from others"** (Public Sector Benchmarking Service, 2005), **and as a way to "learn how to adapt and improve as conditions change"** (Camp, 1989, cited in Jackson, 2001, p. 218). Here, a benchmark is only a starting point from which research is generated, is context-bound, and is also a way of testing practices and processes to see if they measure up: that is, whether they are successful, will be adapted and developed further, or discontinued. This paper describes an Australian longitudinal example at the University of Technology, Sydney (UTS) that involves cycles of continuous institutional improvement of e-learning provision through eliciting the learners' experiences of e-learning, which are influenced by the teachers' design of e-learning in a particular discipline and the dynamic institutional and societal contexts in which both learners and teachers operate.

According to these views, benchmarking could be conceived both as a process of quality recognition, such as matching or testing against inherited, already established criteria on which some judgment of worth is made (hence, a form of quality assurance); and as a process of quality development, such as creating new criteria that are generated from emerging practices and innovations in response to new needs, or contextual conditions or pressures (a form of quality enhancement). In some cases, such as our research-led investigations at UTS, benchmarking is a continuous iterative process of quality recognition and quality development.

However, we now turn to a more fundamental question: what is the nature of quality itself? In his book written as an inquiry into values, Pirsig (1974) asks: "Why does everybody see Quality differently?" (p. 252), and similarly Harvey and Green (1993), in their paper entitled "Defining Quality," note that "quality is relative to the user of the term and the circumstances in which it is invoked. It means different things to different people." However, when Pirsig states that "quality is a response of an organism to its environment" (p. 253), he also opens out for questioning and investigation how the exact same conditions do not exist between environments and how unique individuals might interact and operate within such context-bound conditions. The second feature Harvey and Green describe about the nature of quality is that "in some views, quality is seen in terms of absolutes … [as] an ideal … in other views, quality is judged in terms of absolute thresholds that have to be exceeded to obtain a quality rating." Lastly, they observe that "quality is … a value-laden term: it is subjectively associated with that which is good and worthwhile." Furthermore, Pirsig (1974) suggests that in any context or environment, people make choices based on quality, on value: "we preselect on the basis of Quality … or … the track of Quality preselects what data we're going to be conscious of, and it makes the selection in such a way as to best harmonize what we are with what we are becoming" (p. 315). Harvey and Green (1993) conclude with a recommendation of "looking at the criteria different interest groups use in judging quality rather than starting with a single definition of quality." So, the nature of quality can be characterized as follows: relates to values; entails criteria that are used and developed to make value judgments; and is derived and shaped over time by the subjective experiences of individuals or collective groups as they operate in changing environments with particular conditions and pressures.

Furthermore, through a sharper analysis of the benchmarking mentioned in this introduction and enacted to deduce the quality of e-learning in higher education, we propose that these approaches can be perceived and categorised as top-down and systems approaches. Subsequently, we raise aspects of the literature that critically examine such approaches.

Top-down approaches

Riley, Selden, and Caldwell (2004) explore the Big Change Question, "Do current efforts to initiate top-down changes fail to support the moral purpose of education?", and question whether a top-down approach is the preferred or desirable way for bringing about improvements and reform in Education. In response to another top-down approach (UK government's White Paper, 2003), Gibbs and Iacovidou (2004) argue against such quality criteria that may fail to capture the essences of an educated person and create a pedagogy of confinement of student and academic potentialities through its external measurement of control, and instead suggest trusting the academic community of scholars as an academic community of responsibility. Similarly, Bentley and Wilsdon (2003) state that "public value is created, not delivered … solutions rely, at least in part, on the users themselves and their capacity to take shared responsibility for positive outcomes" (p. 20), and they put forward an agenda: "We need systems capable of continuously reconfiguring themselves to create new sources of public value. This means interactively linking the different layers and functions of governance, not searching for a static blueprint that predefines their relative weight … we need to ask: How can the system as a whole become more than the sum of its parts?" (p. 16).

Systems approaches

Complexity and interrelatedness are inherent to understanding how systems such as learning organizations, with their many parts and feedback loops, operate (Senge, 1992; Axelrod & Cohen, 2000). Though Jacobson and Wilensky (2006) state that "it does not appear that there is a general 'theory of complex systems' at this time" (p. 26), they do anticipate the implications of such system-thinking perspectives: "Complex systems approaches … enable researchers to study aspects of the real world for which events and actions have multiple causes and consequences, and where order and structure coexist at many different scales of time, space, and organization" (p. 12). A contemporary shift in thinking about systems and how understandings of such systems might be gained are explored by Frenay (2006). Moreover, in his commentary, Caldwell concludes that "a response to the earlier 'Big Change Question' is thus a call for an adaptive balance of 'top-down' and 'bottom-up' approaches to change" (Riley et al., 2004, p. 427), signalling the relevance for considering multiple influences in any system, both internal and external.

In this paper, we seek to gain insight into the quality of an e-learning system and to investigate one particular institutional approach (or methodology) for doing so. The paper asks the question: "In a higher education institution, what is the value of a systems approach to e-learning provision driven by students' experiences?" We begin by briefly discussing an e-learning system that is used widely in Australian universities. Then, we describe and analyse the approach one university has taken to understanding the quality of its e-learning system in operation. To gain a detailed understanding of students' and staff's experiences with this e-learning system, we give an account of the UTS's approach to introducing a Learning Management System, and its subsequent attempts to improve the quality of e-learning through large-scale evaluation studies. We discuss how these findings are used to shape the institution's e-learning developments over time and the value of this systems approach at UTS.

Learning management systems (LMS) in higher education

Learning management systems (LMS) such as Blackboard and WebCT integrate a range of online tools, including discussion boards, announcements, email, assessment quizzes, group facilities, and online content areas. Since the wide-scale proliferation and adoption of LMS in the UK, Europe, US, and Australia (Observatory on Borderless Higher Education, 2002; Paulsen, 2002), much has been written about the ways in which such e-learning technologies may afford enhanced experiences for students in terms of improved quality of learning, enhanced productivity of learning (access to education, for example), and/or improved attitudes to learning (see Alexander and McKenzie, 1998; Martin & Webb, 2001). In another study, Coates, James, and Baldwin (2005) note that behind the rapid adoption of these particular systems there have been six drivers, namely:

1. a means of increasing the efficiency of teaching
2. the promise of enriched student learning
3. new student expectations for advanced technologies
4. competitive pressures between institutions
5. a key means of responding to massive and increasing demands for greater access to higher education
6. part of an important culture shift taking place in teaching and learning in higher education (p. 23–5)

Regarding the sixth driver, Coates et al. (2005) argue that:

> LMS offer universities a hitherto undreamt-of capacity to control and regulate teaching. From a managerial perspective, the disorder associated with academic independence and autonomy in the teaching and learning process can appear chaotic and anarchic … LMS may appear to offer a means of regulating and packaging pedagogical activities by offering templates that assure order and neatness, and facilitate the control of quality (p. 25).

Though Coates et al. (2005) view these systems as essentially devices for teaching, they state that attention has been most often focussed on their technical, financial, and administrative aspects. In contrast, our institutional approach seeks primarily to understand the use of LMS as technological environments for learning.

The UTS approach to an e-learning system

As an inner-city university with over 32,000 students and the largest number of part-time students in the state, UTS recognised that in order to meet the needs of these students the university would embark on "flexible learning" as a major strategic initiative in 1996. Flexible learning was defined as, "the name given to a variety of teaching, learning, and administrative practices which meet the needs of a diverse student population in the contemporary social context" (Professor Tony Blake, President of UTS, 1997).

In their longitudinal study, Krause, Hartley, James, and McInnes (2004) provide some insights into what these diverse needs of students in a contemporary Australian social context might be. Their research was first conducted in 1994, then again in 1999 and 2004, and identified a number of important characteristics of students in Australian universities. In 1994, for example, 40% of full-time students reported working 11 hours or more per week. By 2004, this percentage had increased to 49%.

In 1996, the UTS initiative was managed as a top-down and bottom-up project. The top-down aspect involved the setting of a vision for flexible learning and the formation of six Flexible Learning Action Groups (FLAG), each of which was given a small amount of funding and directed to use that funding in a way that would benefit the university as a whole. The FLAG on Internet use met initially on a monthly basis, with the number of academics who attended rising from the inaugural 10 members to around 50 by the end of the first year. The group subsequently evolved to become a very successful community of practice, where academics across discipline areas and faculties tried out various ways of using e-learning for teaching, undertook evaluation of those practices, and shared their successes (and failures), ideas, and practices, thus facilitating the building of knowledge about the practice of using e-learning for learning and designing subjects. The activities of this FLAG group and the introduction of LMS have been described elsewhere (Sawers & Alexander, 2000; Alexander, 1999; Sawers & Alexander, 1998). As well as having a focus around collaborative learning and designing and teaching activities to provide peer support for academics, the group was also instrumental in shaping the nature of technological and learning support to be provided by the institution to academics and students. Some of the early recommendations of this group, for example, included:

- recommendation of a particular learning management system, Blackboard (known at UTS as UTSOnline), to be managed centrally with appropriate backup and software upgrades
- recommendations for centralised support for students and academics in the form of a telephone help-desk and batch enrolment of students
- changes to university policies on promotion and tenure to recognise and reward outstanding e-learning innovations

Now, in 2006, more than 1200 subjects make some use of e-learning, although only a very small minority of subjects have no face-to-face component.

From its inception, the institutional approach to e-learning at UTS has been underpinned by a view that understanding students' experiences is critical to improving the quality of e-learning. The approach to promoting quality of e-learning has as its key driver that no e-learning environment can be guaranteed to generate high quality learning, independent of learners' own experiences (after Boud & Prosser, 2002). Hence, the learning interests, needs, and experiences of students directly inform the institutional decisions relating to e-learning development, and support, through a process of continual evaluation and enactment. We turn now to an account of the large-scale institutional studies (2002, 2004), which set out to gain insights into and understand what students and teaching staff do (and want to be able to do) with LMS, what students and staff value about these uses and why, and students' and staff's experiences in using such technologies as part of their studies and for teaching their subjects.

Evaluation plan (2002 and 2004)

The number of units with some online component had risen from the initial pilot project of one unit in 1997 to approximately 500 units by 2002. The FLAG meetings, once held regularly and attended by some 60–70 academics, now attracted smaller numbers. The authors felt it was an opportune time to evaluate the e-learning initiative to determine its consequences, as well as to provide an opportunity for academics to conduct a more detailed investigation of their students' learning. Use of the term "consequences" was deliberate, and the term was chosen to be broader than "outcomes" so that unintended outcomes might also be included. Volunteers for the project were sought, resulting in the formation of a small committee of academics to provide feedback to the evaluation. The group agreed to the following evaluation plan, which was conceived as an attempt to gain a broad snapshot view of e-learning at the university.

Purpose of the evaluation

One purpose of the evaluation was to gain an enhanced understanding of ways in which academics were using UTSOnline (Blackboard LMS) in conjunction with wider e-learning strategies to increase flexibility of subjects and course offerings.

Other purposes of the evaluation include developing an enhanced understanding of:
- the consequences (outcomes) of the range of online learning strategies used at UTS;
- the student experiences and expectations of a range of uses of UTSOnline (including equity and access);
- the support needs of academics, including technical, administrative, and pedagogical issues.

The evaluation questions

The questions designed to provide a *description* of the use of UTSOnline were:
- What are the various ways in which academics are using UTSOnline (including other uses such as for research, communication)?
- What are the experiences of students using UTSOnline?
- How is the UTSOnline experience integrated within the total student learning experience of a subject?
- What is the level of experience of new academics using UTSOnline (i.e., new to teaching, to UTS, or to the use of Blackboard as a learning management tool)?

The issues related to the *impact* of the use of UTSOnline were:
- What does the use of UTSOnline enable for academics, students and the community?
  - What are the affordances of the range of uses (i.e., flexibility or limitations that have resulted from the use of UTSOnline)?
  - How does UTSOnline use affect flexibility of time, location, and pace of study for students (i.e., usage patterns)?
  - What are the demands on academics and students (e.g., increased/decreased workload)?
- What are the consequences of a range of e-learning strategies?

2002 Evaluation Survey

The student questionnaire in 2002 was developed in collaboration with the evaluation committee and drew upon the bank of questions contained in the Flashlight Student Evaluation Inventory (Ehrmann & Zúñiga, 1997). After gaining feedback on the first draft from the evaluation committee, two students from each of the nine faculties in the university were invited to complete the survey and to provide feedback on the wording and questions. This feedback was then incorporated into the survey, circulated to the committee for final comment, and posted live towards the end of October. Students were encouraged to complete the survey via a link from the LMS's login page and all academics were asked to publicise it. In order to ensure that responses to the questionnaire were confidential, students were not asked to provide any identifying information (for example, their student ID number). Hence, the survey was one in which students could choose to participate or not, and it was possible for students to make multiple attempts to respond. A similar process was used to develop the teaching staff questionnaire, although the pilot was conducted using academic staff rather than students.

At the end of the two-week period that the student survey was available, there were 2,509 valid student responses. However, because of the limitations of the method noted above, it is not possible to provide a reliable response rate. Still, it should be noted that there were 23,682 registered student enrolments in the LMS at the time and, hence, as a general guide, approximately 10.6% of these students completed the questionnaire. It should also be noted that the questionnaire was lengthy, with some questions relating to the Blackboard tool itself and, predictably, less than half the respondents completed the questionnaire. The teaching-staff questionnaire elicited 230 responses, a number that was reduced to 199 after the data was cleaned. During the semester in which the data was collected there were 703 academics registered as users of the system, and hence the individual response rate was approximately 28.3%. For many units of study, however, more than one academic was involved in teaching and therefore, for the purposes of this survey, that data was aggregated. This meant that responses were received for 295 discrete units of study from 501 known units, which had some online component during that semester. Hence, the subject response rate was 58.9%.

2004 Evaluation Survey — Benchmarking with ATN

The 2004 survey repeated the 2002 survey (although with some modifications based on the 2002 experience), and this time in collaboration with four other universities within the Australian Technology Network (ATN). Not only was the authors' university a member of the ATN group, the similarity in course offerings made ATN an appropriate group for benchmarking.

For the 2004 student survey, the same evaluation questions were posed as in the 2002 survey (with the addition of some questions and refinement of others, as already noted) and, with the exception of offering a random prize draw for an iPod, the survey was conducted in the same way as in 2002. The inclusion of the iPod prize appears to have accounted for the increase in valid student responses from 2,509 in 2002 to 6,265 in 2004. Once again similar questions were posed in the 2004 teaching staff survey as in the 2002 survey and in 2004 there were 217 responses (slightly fewer valid responses than in 2002). We note that there were some complaints from teaching staff that, unlike the students, they were not offered the opportunity of a random prize draw for an iPod.

Consequences of e-learning: The UTS experience

It is not possible within the bounds of this paper to report on all the findings; suffice it to say that comprehensive analyses are published in the internal working papers and reports. However, we select two excerpts from the many that could have been chosen from the large dataset to shed light on a system in operation. We subsequently use this data to investigate the value of UTS's approach for gaining insights into the quality of its university-wide e-learning provision. The first data selection gives an account of what teaching staff and students are doing with a LMS technology and why they value these practices, and the second data selection describes how students are using (or wanting to use) the LMS to learn with and from other students. We start, though, with the background into student demographics and students' access to computer technology.

Background

Student demographics

The demographics of the students responding to the questionnaire in both 2002 and 2004 are reported in Table 1. It is not possible to gauge the degree to which the demographics of the survey respondents are similar to or different from the population of students using UTSOnline. The only means of making some judgment about the degree to which the survey population is representative is to compare the demographics with the overall population of students enrolled at UTS, acknowledging the limitations of such a comparision. With this caveat in mind, it would seem that for both surveys there is an over-representation of undergraduate students in the survey respondents, an under-representation of part-time students, and for the 2004 survey only, an over-representation of students who speak a language other than English at home.

Student access to computers and the Internet

In 2002, of the 1200 students who responded to this question, 90.7% reported having access to a computer and the Internet at home. By 2004, students reported higher levels of access to computers and the Internet, with 93% now reporting access from home. Of these, 57.7% had broadband access. The proportion of students reporting access from home was higher than expected when compared to the Department of Communications, Information Technology and the Arts' *Current State of Play 2004* report, which stated that 61% of all Australians aged 2 years and over had home access as of June 2004. In the 2002 survey, most students did not agree that they had trouble gaining access to a computer at university (mean = 2.5 in a Likert scale; 1 = strongly disagree, 5 = strongly agree). Similarly, in the 2004 survey, 81% of students reported having adequate access to a computer at university. Therefore, there was no evidence in either survey (2002 or 2004) that significant numbers of students had difficulty gaining access to a computer to use the LMS either at home or at university.

Table 1. Survey Respondents and UTS students' personal characteristics and enrolment type (2002 & 2004)

		2002				**2004**			
		Survey Respondents		**UTS Student Enrolments**		**Survey Respondents**		**UTS Student Enrolments**	
		N	%	*N*	%	*N*	%	*N*	%
Level of study	Under-graduate	957	78.8	17,318	67.9	4,403	75.7	17,559	64.7
	Post-graduate	257	21.2	8,186	32.1	1,414	24.3	9,567	35.3
Total		1,214	100.0	25,504	100.0	5,817	100.0	27,126	100.0
Enrolment	Part time	317	26.2	8,481	33.3	1,166	20.1	8,172	30.1
	Full time	895	73.8	17,023	66.7	4,644	79.9	18,954	69.9
Total		1,212	100.0	25,504	100.0	5,810	100.0	27,126	100.0
Gender	Male	614	50.7	12,418	48.7	3,025	52.2	13,834	50.9
	Female	597	49.3	13,086	51.3	2,775	47.8	13,292	49.1
Total		1,211	100.0	25,504	100.0	5,800	100.0	27,126	100.0
Language other than English	Yes	533	44.1	10,189	40.1	2,910	50.2	10,373	38.2
	No	676	55.9	15,189	59.9	2,888	49.8	16,753	61.8
Total		1,209	100.0	25,378	100.0	5,798	100.0	27,126	100.0

Data selection 1: What teaching staff and students are doing with a LMS technology and why they value these practices

In both the 2002 and 2004 surveys, the staff questionnaire listed a variety of ways in which the LMS could be used, including the making of announcements, and providing for group discussions, online debates, and formative assessment. The top five ways in which teachers reported using the LMS are listed in Table 2.

Table 2. Uses of UTSOnline (2002 & 2004)

Purpose	**2002** %	**2004** %
Make subject announcements	95.2	97.6
Provide access to materials	91.1	93.7
Provide links to web resources	54.9	73.8
Send emails	51.5	72.6
Use discussion board*	57.7	48.4

* *Note.* There was a variation in wording of this question in each survey so the results are not as comparable from 2002 to 2004 as they might otherwise be.

In the 2002 survey, teachers were asked to provide answers to the open-ended question: "What would you describe as your primary reasons for using UTSOnline in the teaching of these subjects?" (Table 3). There were, however, significant differences among faculties in these responses. Teaching staff from the Faculty of Information Technology, for example, were more likely than other teaching staff to use UTSOnline for primarily administrative reasons, while those from the Faculties of Business and Science tended to use the system primarily as an information tool. The most common reason for using UTSOnline in the Faculty of Education (80% of responses) was to communicate with and between students.

Table 3. Reasons for using UTSOnline (2002)

	n	%
Providing information to students	84	54.2
Communication with and between students	75	48.4
Administrative reasons	45	29.0
Assessment purposes	17	11.0
To improve learning	18	11.6
Supplement f2f classes	29	18.7
Access (flexibility, intern/interstate students)	20	12.9

Base: respondents ($N = 155$)

This question was then refined for the 2004 survey, with respondents asked about their experience of a number of potential advantages of e-learning (Table 4). Also, 60.1% of respondents agreed or strongly agreed that use of the LMS reduced the need to answer student questions by telephone or email, and 55% thought it had facilitated student preparation for class.

Table 4. Teachers' experience of aspects of e-learning (2004)

	Average Rating
Can give timely information	4.4
Efficient in making information available	4.3
LMS available and efficiently administered	4.1
Effective for important communication	4.0
Provides common form of communication	4.0
I can work off-campus	3.7

(Based on a five-point Likert-type scale with 1 = strongly disagree, 5 = strongly agree)

Similarly, students also were asked in both surveys whether they had used particular aspects of the LMS. Again, the wording of questions varied slightly between the 2002 and 2004 surveys (Table 5). In 2004, with the inclusion of new questions, 95.6% respondents said they used UTSOnline to send emails to other students or teaching staff, and 86.6% reported having done self-assessment quizzes.

Table 5. Percentage of students who have used UTSOnline features (2002 & 2004)

Feature	**2002**	**2004**
Access course/subject materials	97.6	99.5
Read announcements	97.5	99.7
Use open discussion board	88.5	92.8
Read community messages	87.6	95.4
Access external links/resources	80.3	98.2
Check grades	79.8	95.6
Participate in assessable discussions	76.5	87.7
Graded quizzes	61.8	79.5
Submit assignments electronically	54.0	85.6

Although the wording of the questions varied slightly between the 2002 and 2004 surveys, students were asked to rate the value of various features that were common to both surveys for UTSOnline (Table 6). In 2004, students also seemed to value sending emails through UTSOnline to other students and teaching staff (3.7) and using self-assessment quizzes (3.7).

Table 6. Average rating of features of UTSOnline (2002 & 2004)

This feature has been valuable to me	**2002**	**2004**
Access course/subject materials	4.3	4.5
Read announcements	4.1	4.4
Check grades	3.9	4.2
Read community messages	3.6	3.8
Graded quizzes	3.6	3.7
Submit assignments electronically	3.5	3.8
Participate in assessable discussions	3.3	3.6
Access external links & resources	3.3	3.9

(Based on a five-point Likert-type scale with 1 = strongly disagree, 5 = strongly agree)

In 2002, students were asked to respond to two open-ended questions, the first being: “Are there particular occasions when UTSOnline was particularly useful to you? Indicate when and how it was useful.” In the analysis of responses, the following is a sample that came under the category of “access to learning”:

- *When studying away in the country during an industrial experience block I was able to continue my studies.*
- *I work in a suburban law firm, so it provided me flexibility to access lectures, instead of leaving in the middle of my work for classes.*
- *I was overseas during the semester . . . but this was transparent.*
- *I am a single mother. . . . It is fantastic if my son is sick and I can’t make it to a lecture.*
- *I suffer bad arthritis in my legs so it was invaluable to enable me to keep up with class announcements and some course materials.*

The second open-ended question asked: “What other comments would you like to make about your experiences in UTSOnline or questions you would like addressed about the use of UTSOnline?” Students identified many issues that were of concern to them, with the most common being the reported differences of experience in teaching staff’s responses to students’ questions posted on the discussion board. While some students’ questions were answered immediately, other students reported not receiving responses from teaching staff at all. It was not clear to students how teaching staff intended to use UTSOnline in a particular subject that the students were studying.

In the 2004 survey, the first open-ended question of 2002 was refined, and rather than being asked about the benefits, students were asked, “What does UTSOnline enable you to do that you couldn’t do otherwise (if anything)?” The qualitative responses were categorised (Table 7).

Table 7. Affordances of use of UTSOnline (2004)

Benefit	*n*	%
Enhanced access to learning opportunities and resources	2,713	52.5
Interactions with others on the discussion board	1,167	22.6
Time and place flexibility	917	17.8
Qualitatively different learning opportunities	209	4.0
Other	161	3.1
Total (*N*)	5,167	100.0

In the category **enhanced access to learning opportunities and resources**, respondents typically focused on the learning benefits of having access to learning resources such as PowerPoint slides of lectures and up-to-date information. A number of students also commented on the value of having access to all course or subject information in one location:

- *In past/current semester/s it has enable you to listen more in class and collect lecture notes after or before - so you obtain more knowledge.*

- *keep up to date with the development of the course, i.e. changed lecture slides, additional material and altered rooms/times*
- *It enables me to find all the information in one place. I no longer need to use diaries etc to organise my subjects*

A large number of responses related to **interactions with others on the discussion board**, and included comments such as the following:
- *email many classmates at once- people that you don't know but need to contact*
- *engage in group discussions that would otherwise be difficult to do as thoroughly owing to not enough time in class and it makes it easier when everyone has different availability.*
- *get answers to simple questions without wasting the teacher's time- either by getting the answer from another student, or having the question simply asked once, with the answer displayed for all to see.*
- *to be able to discuss issues and raise questions with lectures, tutors, other staff and students. To be able to read and learn from problems other students post. To learn from the answers that get posted in discussion threads. Its all a lot easier to do this online than in person.*

The **time and place flexibility** afforded through the use of the LMS was also clearly evident in responses:
- *Study from a distance. I had to move during my studies and UTS Online enabled [me] to transfer my study mode.*
- *Access lecture notes and subject material when i cant make classes. This was GREAT especially when i was overseas!*
- *Spend less time collating information and wasting time submitting material - it allows me to do this remotely, without driving, parking, walking and finding resources are unavailable or inconvenient to use.*
- *It enables me to access information at hours that a suitable to me - a mother of two young children. It is convenient for me to do a lot of my work at home at odd hours, and UTS online allows me to pick up information whenever I want.*

Finally, the responses labelled **qualitatively different learning opportunities** refer to learning affordances that would simply not be possible without the use of a Learning Management System (LMS). While the above-mentioned response categories appear, on the surface, to meet this criterion, they could also be seen as an automation of existing practices, albeit in a form that provides a higher degree of flexibility for students. Some comments included:
- *I have a hearing impairment so I was never good at sharing and obtaining information in university classes. UTSOnline ensures that I do not miss out on information because it is all posted online.*
- *Discussing with my classmates. This wouldn't happen without UTSOnline, since most of the postgraduate students are working besides their studies, meaning they don't spend so much time in Uni*
- *Post "stupid questions" anonymously that I normally wouldn't ask…*
- *I am writing a thesis. It allows me to get critical feedback and ideas from other students and supervisors, even though we rarely see each other face-to-face. It allows us to be familiar with each other's work.*

Data selection 2: How students are using (or wanting to use) the LMS to learn with and from other students

In 2004, feedback from students in the qualitative questions about what UTSOnline enables them to do that they couldn't do otherwise also revealed how students are learning with and from their peers in these e-learning contexts, as well as what they find useful about such interactions. For example, students responded that UTSOnline enables them to:
- make connections and stay connected to other students;
- have discussions with a larger group of people (outside their friendship groups or tutorial class and across all students in the subject or course);
- converse with students outside of class times and continue conversations that start in tutorials;
- have access to a diverse range of ideas and opinions;
- get feedback from many people;
- ask questions and get answers from students with whom they would not otherwise have a chance to interact with;
- view the kinds of problems other students are having;
- use other students' postings as a source of information and to benchmark their own progress or development of ideas; and
- find fellow students and form a group for group assignments when they don't know anyone in the class.

UTSOnline appears to offer qualitatively different or greater opportunities for how students can operate and learn with other students in their studies. UTS students' comments include:

- *It's also good to get feedback from students who are far more knowledgeable in one particular area. It makes it interesting when determining who is a valid source of information and not. I've never had to do this before to such a great extent with other students.*
- *See what other students are finding difficult and learn from their experiences and questions*
- *Discuss issues with the entire group of students. Learn difficult things to do from other students by them explaining how they learnt to do it*
- *Our course requires that we attend Uni on most Thursdays. If something happens at work which relates to the subjects we are studying one would have to wait until the following Thursday to discuss it with other students. Online access means you can debrief more immediately when the event is fresh in your mind and one can share those often intense feelings at a crucial moment.*

Students made comments about how they value the choice and flexibility that comes with having different UTSOnline technologies, which they can select to use depending on their group needs and the task they are undertaking:

- *It makes it much easier for group work! Group meetings are essentially ongoing as opposed to once a week face to face. We can ask each other questions or provide documents and links for each other without the expense of phone calls etc or through group emails. And as everything is left online we can track our conversations and ideas and leave all of our documents online so nothing is lost. It makes life a lot easier.*
- *Its great to have discussion threads so that past discussions are completely traceable, but even more valuable is the ability to attach files to discussions – this allows for storage - and it's a great thing that UTS Online is backed up every day so if our group ever loses anything we know who to turn to :)*
- *Accomplish group work more readily. I am doing [name of subject] this semester; a major group work subject. Through UTSOnline I am able to have my own section allocated to my group in the groups section which allows me and all my team mates to collaborate files, discuss work, and keep everyone up to date on the project through a central position on UTSOnline. This would have been much harder if we had had to setup these facilities ourselves.*
- *Most importantly it enables me to participate in group work without having to be on campus. This is extremely important for me as I work full-time and I only have a very limited amount of time that can be spent on campus.*

In many instances, students talked about the difficulties they experienced when group areas were not set up in UTSOnline (although group work was a requirement in their subject), and their desire to have access to this functionality:

- *I would like to see more support for group meeting boards online for those of us who have group members that are a long way away. Almost all assignments in [name of faculty] are group based, often hard to meet.*
- *not all subjects provide the groups page which is disappointing because I find that function of UTSOnline really beneficial especially when nearly all subjects require group work*
- *Only one of my subjects does not have a UTS online page, and this made file sharing for projects, and contacting class mates very difficult. This has led to more time wasted going into uni for brief group meetings that could have been easier to coordinate over UTS online*.

There were students who mentioned that some things in group work were better done face to face but they also acknowledged that this was not always possible for their group because of varying schedules and the locations of different members. Furthermore, in the staff survey, teaching staff said that setting up group areas in Blackboard was very time-consuming and cumbersome:

- *Setting up groups is a real pain; it takes so long!*
- *One thing is that enrolling students into groups is very awkward.*

Students also provided advice on a redesign of the Blackboard tool. Suggested features for working and learning in groups included:

- *Stuff like editing group work documents – need another way of doing it – would love to see uts online used to track groupwork so that lecturers can see when one or two group members are propping up the rest of the group!*
- *Couldn't post pics of what I was talking about in the body of the message*
- *a group assignment on a poster, was very difficult to discuss layout without being able to see anyone's idea*
- *a group discussion facility can only be set up by a lecturer or tutor. Sometimes it's not convenient for us as we must ask the lecturer or tutor first*

Teaching staff also saw the benefit of students having greater control over setting up, managing and using group areas, for example: “It would be great if we could give students the ability to create new discussion forums in their group areas … currently this is not possible and it is a real limitation!”

Discussion

Both evaluations (2002 and 2004) were useful in general in confirming and gauging the overall quality of e-learning opportunities for students within a particular e-learning system. From these large datasets of quantitative and qualitative responses, there was much evidence that UTSOnline had met “the diverse needs of students in a contemporary social context.” Students reported being able to manage increasingly complex lives, juggling the demands of work, family, and social lives with their studies as a result of these e-learning opportunities. Thus, not only did students make explicit why they value the e-learning system (UTSOnline) and the criteria on which they based their judgments of worth, the survey also provided evidence that use of UTSOnline makes it possible for many students to:

- enrol in a course of study regardless of geographic location;
- access course materials prior to lectures (in some cases using these to make decisions about the value of physically attending a lecture);
- receive notification of changes or cancellation of classes before spending time traveling to university;
- receive updates on administrative and learning issues in between face-to-face classes;
- get to know fellow students via the discussion board, which would not be possible face to face;
- ask questions online that they didn’t feel comfortable asking in a face-to-face situation;
- ask questions when they arose rather than waiting for a face-to-face class;
- compare their own understanding to that of other students through the discussion board;
- track the development of ideas through the discussion board;
- locate other learning resources via links provided;
- test out their knowledge and receive feedback using the quiz facility;
- check marks and grades.

A small minority of students made mention of a preference for face-to-face learning, acknowledging, however, that this was not possible for them.

Teaching staff at UTS choose to use the LMS in specific ways, depending on various factors (including the course/subject relevance and the discipline). As a result of student feedback in the 2002 survey, a change was made to the set-up of online subjects in an effort to communicate these uses to students and to better align student and teacher expectations of teacher participation in online discussions. The following “Levels of UTSOnline Use” were introduced, and all academics using the LMS were asked to notify students of the level they were adopting. These three levels are still in use:

1. Information only. Subject/course outlines, course materials, and content are available. No discussion board.
2. Information and an un-moderated discussion board. Same as 1. above, plus availability of a discussion board for student use only (no teacher presence).
3. Information and a moderated discussion board. Same as 1. above, plus a moderated discussion board with academics making an opening statement about their online involvement — for example, the time frame within which they would respond to student questions.

Then, in 2004, academics were asked which level they were using at the time of the survey (Table 8).

Table 8. Level of use (2004)

Level	*n*	%
Level 1 — information only	75	29.9
Level 2 — information and un-moderated discussions	61	24.3
Level 3 — information and moderated discussions	115	45.8
Total (*N*)	251	100.0

Thus, although the earlier data highlighted the extensive use of UTSOnline for providing content or information, it became clear from this 2004 data that significant use was also being made of the discussion boards.

With the emergence of new mobile technologies and social software (Bryant, 2006), UTS students appear to be communicating across different modes and in different forms, and gauging from their responses in 2004, students want similar opportunities available for learning collectively in formal e-learning environments. In 2006, UTS introduced the Learning Objects Campus Pack building blocks into UTSOnline to provide blog-like journals, wikis, and e-portfolios, so that students could have greater control over LMS technologies for learning with and from other students. For example, the e-portfolio building block (Expo) enables students to create multiples of their own blog-like journals and wikis, incorporating graphics seamlessly as part of their online discussions. Students can also choose to make these blogs and wikis available (or not) for viewing, co-developing, or commenting by everyone in the UTS community or within any of their UTSOnline courses. With the introduction of these new technologies, we are also working collaboratively on numerous research projects with teaching staff across the university, investigating what these kinds of social software environments might be good for in terms of learning, and the possible design variations in different disciplines. It is too early for us to report on those developments in this paper. We have, however, not yet resolved the issue and addressed the expressed student and staff need for finding a technology that would enable students to create and manage their own closed groups to work on peer group projects (including assessments) within UTSOnline.

The findings from the 2002 and 2004 studies enable us to speculate on the value of a systems approach to the institution-wide provision of e-learning at UTS, which centres on students' experiences. Such an approach:

- is sensitive to what is occurring across various levels and in different areas of the university, across higher education institutions, and in society as a whole, and is responsive to any changes, needs, or pressures in these various systems;
- highlights the values that may be operating in the different areas of the university or society, and seeks to interpret the influences of these values on what people (including students and staff) might want to do or which opportunities might be fruitful;
- enables the criteria on which judgments about e-learning are made to be derived or created from the values that become evident in the system. These are used to guide the decisions that are subsequently enacted;
- fuels the generation of questions that might be good for gaining ongoing insights about the quality of e-learning at different levels or in various areas of the university;
- provokes our university to continue to prioritize "learning" as the key value for influencing decisions about e-learning and for initiating particular directions of e-learning development;
- goes beyond evaluation only to research the institution-wide conditions that enable learning in a changing contemporary context;
- minimizes the risks to the university of poor decisions being made (see Diamond, 2005).

Conclusion

Other recent institution-wide survey studies have obtained students' views of LMS technologies and of e-learning, including:

- the features that students used and their perceptions of the degree to which these features improved learning, class management, or both (Kvavik, Caruso, & Morgan, 2004);
- the views of students about the use of a LMS in education (Haywood, MacLeod, Haywood, Mogey, & Alexander, 2004);
- students' perceptions of the pedagogic value of the VLE (Weyers, Adamson and Murie, 2004);
- students' overall experience of a LMS (rated on a scale of "very negative" to "very positive") and how valuable certain features of the LMS were for undertaking a series of nine particular activities (Kvavik & Caruso, 2005).

Our studies sought to elicit from students and teaching staff what they did (and also what they wanted to be able to do) with a particular e-learning technology (LMS), what they valued about these uses and why, and what their experiences were of using such technologies as part of their studies and for teaching their subjects. The findings from our institution-wide studies are used to guide the ongoing development of quality e-learning for students at UTS, which includes working collaboratively with teaching staff in providing quality e-learning opportunities. The UTS systems approach recognises the ways in which each part or level of an e-learning system is interrelated to others. Rather than determining "good practice" in each part of the e-learning system independently of the learner experience, the learning experiences of students drive the continuing development of the quality of these parts and shape the relationship of the parts to the whole system.

However, our 2002 and 2004 institutional studies cannot shed light on *what* students learn and how students learn particular things in different disciplines in these LMS technological environments, or how teachers might design opportunities for such learning in particular fields of study. Other more finely-grained investigations such as Jackson (2005) will need to be undertaken in other courses and subjects that use UTSOnline in ways tuned to the field under study. Moreover, we seek to design methodologies that might enable us to probe and understand what is happening in different parts of the system (as well as the wider field of e-learning itself) and to analyse these carefully for their utility in generating knowledge of the system parts, and concurrently, for their potential interactions with and influences within the system itself (for example, Jackson & Schaverien, 2005; Alexander et al., 2006). In this way, we work towards gaining a better understanding of complex dynamic systems and the diversity inherent to such systems. Also, within our system's worldview and with reference to the technological constraints currently designed into LMS, we question whether powerful educational collaborations with developers of LMS technologies could be established, with learning as the prime driver of design, to explore the possibilities and distill the principles that might guide future technological innovations. Though Gibbs and Gosper (2006) raise a call for teacher and developer collaborations in the development of learning technologies, we extend this notion to question what stake learners might also have in such a process (see Alexander, 2004a; Gershenfeld, 2005; Alexander, 2004c).

Nevertheless, as we progress through this early phase in the generation of learning technologies and with all the constraints evident in these embryonic developments, our approach takes a broader view of technology itself — as a tool, as a practice, as a system (Alexander, 2004b), and as a natural adaptive behaviour (Jarvis & Cosgrove, 1997) — and recognises that these two large-scale studies take a coarse-grain snapshot of e-learning:

> as a technological system of intertwined parts including participants (staff and students), practices, tools, and context, all interacting to result in particular consequences … [these studies recognise and seek] to further illuminate a system in which particular e-learning practices might be effective for particular groups of learners, in particular contexts (Alexander, 2004b, p. 5).

Notwithstanding a "technocentric" focus (a term coined by Papert (1987, 1990) to express the tendency to give a centrality to a technical object and to refer all questions to the technology — for example, "Will technology have this or that effect?") that is currently prevalent in the field of e-learning, we, like Papert, want to investigate how and why *people* use technologies, *what* learning becomes visible in technological environments, and which conditions enable ongoing progression in dynamic systems, with an understanding that "the context for human development is always a culture, never an isolated technology" (1987, p. 23). So, our systems approach to the institution-wide provision of e-learning and the pursuit of technological designs *for learning*, encompasses Castells' view (2001) that:

> . . . we engage in a process of learning by producing, in a virtuous feedback between the diffusion of technology and its enhancement . . . It is a proven lesson from the history of technology that users are key producers of the technology, by adapting it to their uses and values, and ultimately transforming the technology itself (p. 28).

It is only through this kind of systems process involving continuous cycles of generating opportunities and receiving feedback that we believe we can learn and develop high quality e-learning experiences for our students.

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Embedding Quality in e-Learning Implementation through Evaluation

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ABSTRACT

In relation to quality, evaluation is often used synonymously with quality assurance and monitoring processes (Ehlers et al, 2004). However, evaluation has other purposes, such as for development and knowledge (Chelimsky & Shadish, 1997). In this paper, I present a view of evaluation as an instrument of quality enhancement rather than quality assurance, one that can be used creatively and powerfully to strengthen an initiative. The case example is a five-year evaluation study of an institution-wide implementation of e-learning. The evaluation framework developed for this study has been constructed with three purposes in mind: monitoring, development, and knowledge. In this paper, I argue that the participatory nature of the devised evaluation framework has enhanced the quality of the initiative and afforded its embedding within pedagogical, technological, cultural, and organisational domains.

Keywords

Evaluation, Quality enhancement, e-Learning implementation, Organisational change

Introduction

"When one sees the best, it is something to be cherished. Quality is related to cherishing, an intellectual emotion. It can be felt by groups but remains tied to personal experience" (Stake, 2004, 287).

In the context of e-learning, quality comes in many forms and has a range of foci. Quality can be perceived in terms of degree of sophistication, satisfaction surveys, adherence to guidelines, "fitness for purpose," and so forth. A further dimension of quality emanates from the teacher's expectations of course quality as the alignment of teaching tasks, learning activities, and assessment as well as reported levels of student satisfaction. In this dimension, there is no distinction between e-learning and conventional learning. Consequently, in the e-learning evaluation area, there has been a tendency to adopt measures that are widely accepted in the general field of training and education, based on evaluation models such as Kirkpatrick's four-level model (1998). General quality instruments (ISO, EFQM, TQM) have also been applied variously, and only rarely have new metrics been devised that consider in detail the quality aspects specifically of integrating e-learning into educational programmes, such as the Embedded Learning Technologies Institutionally (ELTI) project (2003) and Bacsich's 2005 benchmark taxonomy.

A predominant focus in discussions of quality in e-learning centres on the product of e-learning, such as a course, a tool, or even a new mode of delivery. There is a tendency to regard the product in isolation from the systems, processes, and culture surrounding its implementation and consequently pay little attention to the requirements and responsibilities of a wider group of stakeholders than the course or product development team, tutors, and students. A distinctive feature of e-learning is, however, its dependence on institutional infrastructure and access to technologies beyond the control of the tutor. The course, therefore, is reliant upon a greater range of services than those courses that do not make use of e-learning. The focus on e-learning as a product is prevalent in e-learning tool or content development, but also in consideration of e-learning courses. For example, Connolly, Jones, and O'Shea (2005) consider a model of quality assurance that fits with the UK quality-assurance regime. They identify four aspects of quality assurance in relation to e-learning, where e-learning signifies the delivery of courses within university learning contexts using web-based technologies, often blended with face-to-face delivery. They have developed a model that assures quality through examining the coherence in the structure of the course, the quality of the materials, and students' testing of those materials, and have made adjustments accordingly. The focus of their study is bounded by the extent of the course and, to some extent, its delivery. This approach, however, does not make explicit the reliance on those designing and delivering the course to make the adjustments required to assure, or improve, quality.

I contend that quality cannot be assured or enhanced at this level alone; the responsibility for quality is far broader and reaches up, down, and through the organisation. For an institution to develop e-learning provision, it needs to acknowledge its effects at an organisational level. With e-learning, the fundamental concept of course-based learning is challenged, and the emphasis shifts more to the learner, wherever and whenever they engage: "This form of learning, for example, makes it possible to match provision to individual needs after the fashion of 'learning just in time' and to move away from the Taylorian principle of learning and teaching, 'the same for all at the same time and place' (in the instructional paradigm of a classroom scenario)" (Ehlers et al., 2005, 71).

E-learning challenges the tutor to adopt new roles and accept new modes of learner engagement, which, in a blended learning context (where some face-to-face learning still continues), requires substantial re-thinking of the entire curriculum. This is contingent on institutional priorities, strategies, and resources.

I argue that e-learning development has an impact on the existing teaching and learning environment and on ways of thinking and practising within the organisation, as well as within the disciplinary specifics of the courses offered. The introduction of these new processes places the implementation in the arena of organisational change management, which seeks largely to overcome barriers to change and promote innovation. There is a rich literature on change management, although it has been criticised for reinforcing “the dominance of the view that organisational change is inevitable, desirable, and/or manageable” (Sturdy and Grey, 2003). Sturdy and Grey perceive a recent trend in change management theory away from more managerial perspectives with considerations that extend “beyond the organisation as an isolated entity” (p. 653). They argue in favour of “stability” as a challenge to the discourse of perpetual change. In the context of a higher-education organisation, upholding quality is a mark of that stability. The rapid pace of change that technology demands of the educational environment, with upgrades and new technical possibilities emerging continually, heightens the tension between the urge to innovate and the need to ensure suitable quality processes are in place. Integrating evaluative approaches into the innovations eases this tension to some extent, as I intend to demonstrate in this paper.

In this paper, I am therefore more concerned with e-learning implementation as an ongoing process or programme rather than a technology product or course offering. The case I discuss here relates to a large-scale implementation of a specific learning technology, namely a virtual learning environment (VLE), as an enhancement to the learning and teaching infrastructure of one particular university. Although e-learning took the form of an initiative driven by senior management, it was a long-awaited response to a need within the faculty base and amongst many students in 1998 for there to be greater access to technologies for learning and research, in particular web-based technologies (Deepwell & Syson, 1999).

Background to the case study

Coventry University is a medium-sized, modern university in the Midlands of the UK. As with most other modern universities in the UK that were former polytechnic institutions, the student body is largely undergraduate and very diverse. The university specialises in a few high-profile courses and research areas and has well-established links to the commercial and public sector, which generates so-called “third stream” funding (in addition to the two traditional funding sources of research and teaching).

In 1997, the institution launched a major change management initiative to revitalise the learning and teaching practices within the institution under the name: Teaching, Learning and Assessment Taskforce. The taskforce comprised more than 20 experienced academic innovators who debated and developed new ways to deliver higher education into the 21st century. Through the various projects under the taskforce initiative, it became evident that access to suitable technologies was one of the biggest barriers to improvements in practice (Deepwell & Beaty, 2005). In light of these findings, the university management responded by deciding to offer a fully supported virtual learning environment across the institution, which provided easy access to a range of basic web tools. From the outset, evaluative processes were set in motion. It is these processes and the emerging framework that have influenced the development of e-learning implementation within the university and ensured that the focus of technical developments remains on academic-quality enhancement.

There have been several phases in the e-learning implementation, starting with a major pilot from September 1998 (in one faculty), a full-scale roll-out in 1999 (across the university), further expansion in 2000 (across the university and related partnerships), and continuing process and technical improvements and enhancements since then.

Role of evaluation within quality assurance and quality enhancement processes of e-learning

“Quality is seen differently by different people. It is not the job of the evaluator to find a consensus but to weigh the evidence, make judgements, and report the different ways merit and shortcoming are seen. Observations and interpretations that do not agree do not necessarily indicate a failing of evaluation but perhaps the complexity of the program and its contexts. It is problematic to assume that there is a simpler world behind the world that people see" (Stake, 2004, 286).

According to Ehlers et al.'s (2004) EQO model for the analysis of quality approaches, there are a number of classifications that determine the nature of the approach to quality. Three examples are: **the focus**, that is, whether the quality inheres in the product or the process; **the method**, for example, benchmarking, evaluation, or management approaches, and whether **the approach** is of a quality model or quality instruments, or both (Ehler et al, 2004, xx).

Evaluation has a role to play in all these classifications. However, I suggest that in considering a large-scale organisational intervention, such as the implementation of an e-learning initiative, the approach is most productive when the focus is on the process and is presented as a quality model that makes use of a wide variety of quality instruments but does not prescribe them. Another aspect of the quality dimension is that it applies to all levels within the organisation, from the micro level of the individual instance of a learning encounter, through the meso level of programme and departmental decisions and strategies, to the macro level of the whole organisation's policies and practices.

My focus in this article, therefore, is on evaluation methodology as a powerful means by which to ensure that quality, and stability, is considered as an integral part of e-learning implementation. Consequently, the methodology for evaluation that I propose is closely related to programme evaluation (Shadish, Cook, & Leviton, 1991) as opposed to course evaluation or student evaluation. Programme evaluation is normally concerned with the evaluation of social interventions, such as school development plans, housing schemes, and children's welfare reform. The implementation of e-learning involves a similar degree of complexity in that the initiative cuts through many organisational divisions and makes explicit the processes that support student learning in the widest possible sense. This is reflected in the detail in the UK's Quality Assurance Agency guidelines for distance learning, including e-learning (QAA, 1999). The six areas identified are briefly:

- system design
- academic standards
- management of programme delivery
- student development and support
- student communication and representation
- student assessment.

Evaluation of e-learning clearly reaches beyond the bounds of the formal extent of a technological or pedagogical initiative and into areas of activity that may not initially see the intervention as relevant for them (finance, registration processes, assessment regimes, study support, etc.) and may influence policy far more widely than anticipated by institutional or departmental e-learning strategies. The introduction of e-learning affects not only the learners and tutors directly involved in its delivery, but it also affects the spectrum of institutional processes to support all learners off-site, and at all hours of the day or night. E-learning also impacts on what is not e-learning, for example in a blended learning mode, there needs to be a balance and coherence about what is encountered by the learner online and in the classroom. These two aspects of the blended learning should be complementary rather than additive to the load on both learner and tutor. Similarly, the quality assurance mechanisms need give validity to both aspects.

Evaluation of e-learning as a quality mechanism, therefore, should extend into these complex areas. There are a number of methodologies current in programme evaluation, although recent evaluations of social programmes in the US and increasingly in the UK are encouraged to adopt the "gold standard" of randomised control trials rather than more responsive (Stake, 2004), deliberative, democratic (House, 2001) empowerment (Fetterman, 2001) and other similarly exploratory practices in evaluation. However, I propose that it is the more organic and naturalistic methodologies, rather than controlled experimentation research, that help to define the "process use" (Patton, 1997) of the evaluation, and frequently yield the more practical benefits of evaluation for quality assurance and enhancement. As Stake and Schwandt (2006) assert in a recent chapter that explores quality in evaluation and distinguishes between quality-as-measured and quality-as-experienced: "Evaluation studies are fundamentally a search for and claim about quality" (Stake and Schwandt, 2006). The balance between measuring (using broadly quantitative techniques) and experiencing (using perceptual and qualitative techniques) is a fine one. In the case of Coventry University's e-learning implementation, an evaluation framework has evolved, a framework that attempts to harness some of the finer details through participative, contextualised inquiry, interviews, and observations as well as through the application of quantitative measures, such as surveys and statistical reports.

A structured, conversational approach to evaluation

The evaluation framework proposed here draws on three main influences: a countenance approach (Stake, 1967); action evaluation (Rothman, 2003) and report and respond (Stronach & MacLure, 1997). Distinctive to the approach is that it permits insider evaluation, led by internal agents within the organisation who are well placed to use the evaluation research on an ongoing basis to guide and influence decision-making.

Stake's countenance approach to evaluation is represented schematically with three phases: antecedent, transaction, and outcome. At each phase there are two categories of data: descriptive data and judgement data. The process of countenance evaluation is to portray both the degree of congruence between the descriptive data and the judgement data and the logical contingency between the intents and outcomes of each phase with the next. The term "portrayal" is significant here, because a distinctive aspect of countenance evaluation is the generation of depictions of what is observed. What is observed is then compared with the intended outcomes of the programme, and inferences can then be formulated. These inferences not only identify the intended outcomes that have or have not been achieved, but also identify the unintended and observable outcomes of the programme (Stake, 1967). For the evaluation of the e-learning implementation, the strength in this approach lies in its facility in organising a large amount of quite diverse data.

A second guiding influence on the development of the evaluation framework is taken from the arena of conflict resolution, namely, action evaluation. In action evaluation, there are similarly three phases: baseline, formative, and summative. Action evaluation is, unlike countenance evaluation, very much a participatory evaluation method and involves stakeholders from the outset. The purpose of the evaluation is to make a difference to the actions of individuals and groups within the stakeholder body. Therefore, stakeholders are involved at all stages of the evaluation. For example, in the first, baseline phase, stakeholders identify what the terms of success might be for the intervention on an individual, group, and organisational level. The emphasis is not only on the "what," but also on the "why," thus making explicit inner motivations for action (Rothman, 2003). This approach was helpful in providing a context for the evaluation meetings held intermittently throughout the evaluation process.

The third major element to the evaluation framework is a reporting method taken from Stronach and McLure's work on educational evaluation (1997). According to this method, the evaluator presents a structured report to the stakeholders at a number of points within an evaluation. In the report the evaluator makes provisional, and sometimes provocative, statements resulting from analysis of documentation, discussions, and observations. The report raises questions for consideration by the readers, and provides space within the printed document for the insertion of stakeholder responses, be they further clarification, correction, support, or objection to the evaluator's formulations. This approach enabled early feedback on the evaluation work and brought to light useful additional viewpoints and facts that increased the validity of the evaluation work.

The evaluation processes and where the different approaches sit are represented schematically in figure 1.

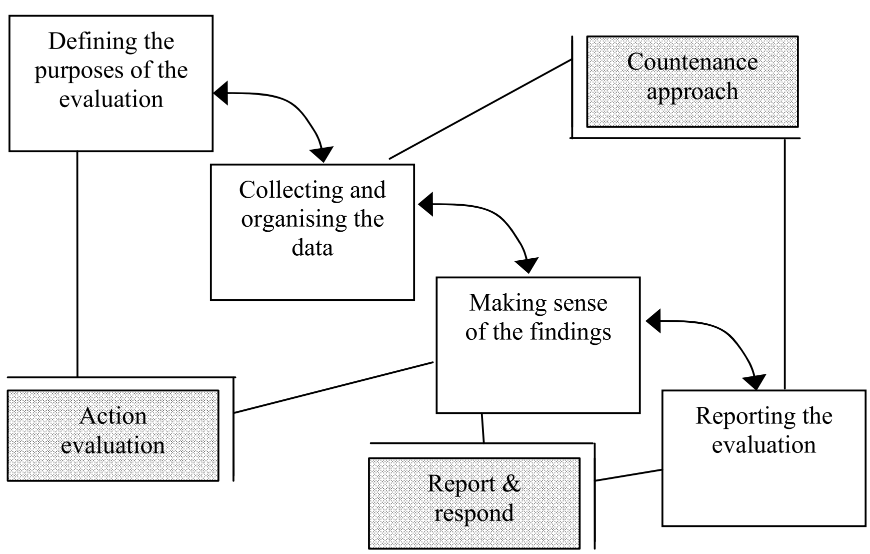

Figure 1: Needs Title Here

How these three approaches were combined in the case study

Together, these three influences shaped an evaluation that was conversational in tone and yet structured around some clear statements of intent and jointly agreed measures.

Consequently, in the first instance and at a very early stage in the initiative, the evaluation sought to identify what the intended outcomes of the initiative were. In the e-learning implementation there were clear drivers from management that defined the intended outcomes, but other stakeholders' perspectives were also incorporated into some initial statements of intent. These initial statements were presented at a stakeholder meeting early in the evaluation process, and ideas were generated at the meeting and through an ongoing open dialogue on ways to gather data that might assist the evaluation process. Electronic means of communication and data collection were exploited as far as possible. Email exchanges, websites of information about the initiative, and interactive feedback sites were established. Over the first year of the initiative, one stakeholder maintained a diary in the form of daily emails to herself about her experiences and interactions relating to the e-learning implementation.

At other key stages in the evaluation cycle, there were opportunities for exchange. The evaluation was presented for discussion at the annual staff conference and at team meetings, and regular submissions were made to the university learning and teaching committee with questions to prompt discussion of interim findings. From the outset, therefore, the evaluation of this initiative was interwoven with quality processes.

Overview of data collected for the evaluation

In line with the methodological approach of the evaluation, data collection for the evaluation was located within the institutional processes, and stakeholders were encouraged to collect data through small-scale evaluations within their own areas. In addition to the application of centralised evaluation tools, the evaluation was undertaken more locally, through the critical mass of informants in the taskforce, which included innovators in e-learning, other teaching innovators, educational developers, and technologists.

Much of the data was collected through observations and evaluation processes within naturally arising settings such as awaydays (off-site workday meetings), course and departmental meetings, and annual quality processes. As already mentioned, the evaluation made use of the interactive elements of the Internet. The virtual learning environment itself was used to elicit feedback from users, as were email and Internet surveys and feedback pages on the web. There were some local questionnaires and focus groups organised mainly in collaboration with teaching colleagues and often within an action research paradigm. There was also an annual feedback survey for students completing the induction session on e-learning. (All entry students, both undergraduate and postgraduate, attend a one-and-a-half-hour induction into online facilities based upon familiarisation with the virtual learning environment but also including the online library and general computing.) Data was derived from reports and committee documents, such as the quality-monitoring course reviews and faculty reports submitted annually to the quality assurance committee. These reviews and reports identify good practice in relation to learning and teaching developments, as well as clarify actions to be taken on particular concerns that are often raised by external examiners or students on course-consultative committees. Case studies have also been developed of specific instances of e-learning use in order to assist others in the development of their own e-learning practices. However, these also yielded some valuable data regarding motivations for using e-learning, disciplinary preferences, student and peer feedback, and fit of the innovative approach within the broader subject or departmental context. In figure 2, I have attempted to tabulate the different data sources in terms of institution-wide (centralised) sources and local (distributed) sources.

Centralised data sources	
	• student surveys (annual) • staff-impact surveys (annual) • server data • VLE statistical data • Quality monitoring reports • Committee and working party reports • Interactive websites • Workshops and seminars
Distributed data sources	
	• Diaries and personal accounts • Interviews

	• Focus groups • Action research projects • Observations • Peer reviews of teaching • Web access patterns • Course review documents • Case studies • Intra-institutional consultancy

Figure 2: Data sources informing the evaluation

A comment on data derived from server statistics

Also collected, analysed, and distributed were data regarding the web-usage statistics, which were generated from the main server that hosts the virtual learning environment. Because of the interest that usage statistics generate, particularly amongst managers within the institution, it is worth saying just a few words about the web statistics and how they have been used within this particular evaluation. Depending on the virtual learning environment architecture and the version of the software, there are different ways to harvest data on usage statistics. The account here relates to various versions of WebCT — from version 1.3 to Campus version 4 and into the pilot phases of using WebCT Vista.

From within the virtual learning environment itself, the data that can be collected is presented as tracking data, gathered cumulatively over time. The views of the data can either be in relation to individual student access (to the site, the content pages, discussion postings, quizzes, or surveys) or content access (how many users have looked at the pages and for how long; how many have completed the quiz and what their scores are). Also, on the server itself are usage statistics that show, for example, the frequency of access to the server over a period of time, where users have accessed the site from, how many users have accessed the homepage of a site, how many times a file has been viewed, and how many discussion postings an individual user has read or posted.

In the evaluation case presented here, tutors made some use of the internal data in conducting their own evaluations of usage and determining participation and performance rates. The statistics collected centrally were also largely based on internal statistics. The emphasis was placed on numbers of initial visits to the homepage of the module site as an indication of e-learning activity, or online sessions. The figures were not used in isolation, but were related to the number of students registered on each module, and a calculation of activity was generated. The actual figure produced is not significant in itself, since there are too many uncertainties about the nature of the visit that generated the statistic. However, the figures do become interesting when they are compared with the activity figures of other modules and when they are charted over time. In this way, the evaluation began to compose a pattern of usage across the institution, which could be represented at the departmental level, and shows relative growth over time. In the three years that such data was systematically analysed (2000–2003), there was a rise from 24% active usage of modules to nearly 50% across the entire curriculum. Within this aggregate statistic, however, there was substantial variation between university departments. For example in 2002–2003, all modules in economics and disaster-management courses fell into the "active" category. In a further seven discipline areas, including computer science, sports science, environmental, and business courses, it could be seen that the active measure was between 75–90% of modules.

The picture that emerges from the usage statistics is acknowledged to be partial, since it measures only one aspect of interaction with e-learning, namely, access to the virtual learning module site. There are other e-learning activities that have not been part of the map of usage, for example, where course level activity is high (as opposed to the module level), or where modules are delivered either together or in sub-components and therefore use additional sites which fall outside those that are counted.

Analysis of developments in the four domains

These wide-ranging data sources listed above have fed into a detailed analysis, organised around Stake's countenance approach to evaluation (1967). It was particularly insightful to compare the intended outcomes with the observed outcomes in the early stages of the implementation and subsequently. Stake's approach also helped to extract the contingency of outcomes on each other. The overall analysis of the e-learning initiative can usefully be divided into four broad domains: pedagogical, technological, cultural, and organisational. There are elements in each of these four domains that have been strengthened through the participative evaluation methodology applied in this case, and in this regard, therefore, I argue that they have enhanced the quality of the e-learning implementation.

Considerations in relation to the four domains identified above are represented in figure 3.

Pedagogical Domain	**Technological Domain**
• Disciplinary and interdisciplinary cultures • Teaching, learning, and assessment regimes • Educational development practices • Profile of students	• IT support • Access (on and off site) • Virtual learning environments, • Software availability and expertise • Licensing conditions
Cultural Domain • Language • Visions • Resistances • Personalities • Communities of practice • Change agency	**Organisational Domain** • Rules and procedures • Policies and strategies • Reward structures • Resources • Quality assurance and enhancement agendas

Figure 3: Representation of developments in the four domains (adapted from Cousin, Deepwell, Land, & Ponti, 2004)

Pedagogical domain

Pedagogical developments in relation to the e-learning implementation include disciplinary and interdisciplinary cultures: teaching, learning, and assessment regimes, educational development practices, and profiles of students.

The evaluation afforded opportunities for re-considering how educational development practices are conducted. Early discussions within a strategy group resulted in setting up two strands of central and faculty-based support for colleagues using the e-learning system — one more pedagogical, from an academic colleague, and the other more technical, from a member of the technical support team. The quality of support provided by academic colleagues for their peers proved to combine pedagogical and technical assistance and was rated very highly. As well, the role was developed into a more strategic academic one. Technical support from technicians was rarely sought for anything beyond password access, and it emerged through interviews with the technical colleagues, that the role was not sustainable. More generally, the faculty-based and central support fostered collaborative developments on both small and larger scales, for example, peer reviews of sites, holding focus groups with student groups on specific courses, collaborating in developing a distance learning certificate in peace and reconciliation (Courtney, 2004), fostering goal-setting techniques through e-learning in first-year undergraduate sports scientists (Smith & Deepwell, 2004), and researching student motivations in e-learning (Davidson & Orsini-Jones, 2002).

Technological domain

Technologically, the enhancements through evaluation were evident in areas such as access to information technology and support provided to users. Virtual learning environments were also evaluated against a set of criteria formulated at a workshop with stakeholders. One significant example of the evaluation influencing policy relates to software and licensing conditions, in which the evaluation provides evidence that the majority of users of web-based services accessed the services off-site rather than on-site. The information service group had to alter licensing arrangements accordingly and start to provide more comprehensive off-campus computing facilities. The quality of the e-learning service provided to staff and students has consequently been enhanced. Another aspect in this domain relates to the provision of third-party software that is user-friendly for faculty to use in developing their teaching materials to distribute in the VLE, and the associated support materials for such software that extends the functionality of the central e-learning package, such as tools for building web pages, quiz construction, compression of large presentation files, etc. The demand for support materials online has led to the ongoing development of web-based support materials, which increasingly use screen movies to demonstrate the use of tools and functions within the e-learning environment.

Cultural domain

In the cultural domain, the evaluation paid attention to language and the emerging visions for the future. It also considered the resistances (perceived and actual), personalities, and power relations within the stakeholder groups. One major group of stakeholders was a set of 25 innovative teachers, the previously mentioned taskforce for learning, teaching, and assessment, who worked individually on educational development projects and simultaneously contributed as change agents within their local settings. (For more about the taskforce with respect to the e-learning implementation, see Deepwell & Beaty, 2005.) Through an engagement with the participative evaluation processes, many of this group of stakeholders became evaluation researchers of their own practice and presented case studies at local seminars, the annual university-based learning and teaching conference, and national and international forums on e-learning. This evaluation activity contributed to the cultural climate that launched a 2005 initiative to establish a pedagogical research network with e-learning as one of the identified strands of activity, thus further building the capacity to research and evaluate practice.

Organisational domain

Within the organisational domain, the evaluation raised considerations for adjustments to rules and procedures, policies, strategies, reward structures, resources, and quality assurance and enhancement agendas. The pedagogical lead that was taken in the e-learning initiative by the Centre for Higher Education Development was valued by many of the academic colleagues, since it preserved to a large extent the autonomy of academic colleagues over their online teaching space, whilst providing a starter template already populated with some central resources and student registrations. This lead was not so highly valued by many of the middle and senior managers, however, unless they were still actively teaching in their disciplines, since they were not directly involved in the processes of change. Within this group of stakeholders there was a reliance on twice-yearly production of the student usage statistics, since this soon came to be a performance indicator for senior managers, upon which their bonus salary depended. Internally, the e-learning initiative rapidly became a core activity, reflected in membership of key policy and strategy development groups, as well as in, for example, ICT skills as a requirement listed in most job advertisements for new teaching staff. Externally, the quality of the profile of the university was raised, too, with presentations and publications emanating from the various aspects of the initiative and its evaluation. Several stakeholders acted as consultants to other institutions, too, such as neighbouring colleges of further education and other universities in the UK and abroad.

Conclusion and implications in e-learning quality

In this paper, my theme has been the integration of evaluative approaches into the development of e-learning in order to enhance and assure the quality of the e-learning implementation. The context described in the case study here was institution-wide and set within a broader change management initiative. The evaluation processes were embedded within the regular cycle of the implementation, and data was gathered both purposively and opportunistically. Evaluation research was used to guide the processes, and a framework was applied that helped organize the wide range of disparate data collected. The gathering of data occurred both from a central point and from distributed sources. In this sense, therefore, the evaluation was a collaborative activity in itself.

The participatory and conversational elements of the evaluation were attended to, in order to increase buy-in to the e-learning initiative as well as the evaluation process. In consequence, the evaluation was influential in decision-making with regard to technical infrastructural demands, which require cross-institutional co-operation, if not collaboration, to achieve.

Conversely, the evaluation team also faced great pressure from management to report annually on the statistical uptake of e-learning. The annual return on module activity was effective in prompting local action. However, in response to the variation in uptake across different courses, for instance, there was not necessarily any substantial consideration of the underlying factors, such as a lack of reliable computer provision in offices or out-dated teaching facilities.

The evaluation approach taken has raised awareness of research and publication opportunities within e-learning and disciplinary learning and teaching areas. Because of the involvement of a wide group of academic colleagues as active evaluators of their own teaching areas, there has been a growth in evaluation capacity within the institution.

Through a discussion of the evaluation framework and the analysis of evaluation findings described in this article, I have sought to identify some of the complexity of evaluating an e-learning implementation. The developmental aims of the evaluation process adopted for this e-learning implementation can be summarised as follows:

- enabling more effective decision-making processes
- achieving widespread buy-in and growth of the initiative
- fostering cross-university collaboration
- creating opportunities for research and publication
- building greater capacity for evaluation within the organisation

In this paper I have reported on a completed cycle of evaluation that accompanied the first major phase of e-learning developments at Coventry University. The evaluation framework has combined Rothman's action evaluation as an underlying philosophy, Stake's countenance evaluation as a data organisation and analysis technique, and Stronach and McLure's report-and-respond method for engaging stakeholders. The evaluation has yielded a rich array of outcomes and findings which have been used to assure and enhance quality within the developmental stages of the initiative.

As outlined above, the evaluation outcomes include development of capacity and understanding of evaluation within the organisation. This, I contend, has been achieved through the development of embedded, participatory, and quality-enhancement-focused evaluation practices. A second cycle of development with a new generation of e-learning systems is now underway.

Epilogue

This paper arose out of a conference presentation in which I likened the evaluation approach described here to the actions of the swallow in Oscar Wilde's fairy tale of the Happy Prince. In the story, the Happy Prince is a statue that sits high above the city where the actual prince used to rule. From this vantage point the statue can see the injustices beneath him (the need for improvement) and decides that he can make a difference. He commands a swallow to take his jewels and gold leaf and to distribute the riches into the community below, thus spreading happiness and improving the quality of life. The swallow is delicate and unobtrusive, but the impact of its actions is significant.

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A Framework for Evaluating the Quality of Multimedia Learning Resources

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ABSTRACT

This article presents the structure and theoretical foundations of the Learning Object Review Instrument (LORI), an evaluation aid available through the E-Learning Research and Assessment Network at http://www.elera.net. A primary goal of LORI is to balance assessment validity with efficiency of the evaluation process. The instrument enables learning object users to create reviews consisting of ratings and comments on nine dimensions of quality: content quality, learning goal alignment, feedback and adaptation, motivation, presentation design, interaction usability, accessibility, reusability, and standards compliance. The article presents research and practices relevant to these dimensions and describes how each dimension can be interpreted to evaluate multimedia learning resources.

Keywords

eLera, Learning resource, Quality, LORI; Learning object

A framework for evaluating the quality of multimedia learning resources

The number of reusable digital learning resources available through search engines and repositories is rapidly increasing. Teachers, students, and instructional developers can access large repositories such as MERLOT (Malloy & Hanley, 2001), which contained more than 15,000 resources when this article was written, and even larger meta-collections such as the US National Sciences Digital Library (Mardis & Zia, 2003), which allows users to search hundreds of repositories. However, the accelerating quantity and complexity of online resources is focusing attention on their inconsistent quality (Liu & Johnson, 2005). There are significant challenges to effective summative evaluation, in part because review processes and tools must balance assessment validity against throughput. Exhaustive and detailed instruments used by some school systems to evaluate educational software packages (e.g., Small, 1997; Squires & Preece, 1999) may not be suitable for evaluating learning objects, which tend to be smaller and more numerous. In this article we consider quality criteria specifically for multimedia learning objects, which we define as digital learning resources that combine text, images, and other media and that are intended for re-use across educational settings (Hamel & Ryan-Jones, 2002; Parrish, 2004).

We believe evaluation instruments designed specifically for these smaller digital resources are needed for three reasons. First, the design of multimedia learning materials is frequently not informed by relevant research in psychology and education (Nesbit, Li, & Leacock, 2006; Shavinina & Loarer, 1999). This has resulted in easy access to many ready-made learning objects of varying quality, making the process of sifting through repositories or the Web to find high-quality resources time-consuming and impractical. Second, to mitigate this search problem, some resource repositories use quality metrics to order search results (Vargo, Nesbit, Belfer, & Archambault, 2003). The efficacy of this technique is directly dependent on the validity of the evaluation tool used to generate the quality ratings. Third, quality criteria for summative evaluations have the potential to drive improvements in design practice (Nesbit, Belfer, & Vargo, 2002). Although our focus is on a tool for use by consumers of learning objects, we recognize that many consumers also have roles to play in the development of new learning objects. By increasing awareness of quality criteria, summative evaluations can feed-forward to improve the design and formative evaluation processes of future learning objects.

LORI: A tool for summative Discourse

The Learning Object Review Instrument (LORI) is a tool for eliciting ratings and comments from learning resource evaluators; it is available as both a web form and printable document at http://www.elera.net (Nesbit, Belfer, & Leacock, 2004). The specific purpose of LORI is to support evaluation of multimedia learning objects. While LORI can serve as a component of a program evaluation process, it is not a sufficient tool for evaluating whole educational programs in which the learning objects may be embedded. Although LORI can be used in a variety of evaluation models, we have used it primarily as part of the convergent participation model for collaborative learning object evaluation. In collaborative participation, reviewers first independently evaluate a set of objects and then discuss their divergent ratings (Nesbit, Belfer, & Vargo, 2002). For further discussion of this and other evaluation models, see Nesbit and Belfer (2004).

In Canada, LORI is being used to teach learning resource evaluation at Athabasca University and Simon Fraser University. In the United States, it has been adopted as a learning object evaluation tool by the Southern Regional Education Board (SREB), a consortium of educational institutions in 16 states (SREB, 2005). Our research group has used the instrument to investigate collaborative evaluation and its role in professional development of instructional designers (Richards & Nesbit, 2004; Vargo, Nesbit, Belfer, & Archambault, 2003). This paper outlines the theoretical foundation of LORI.

Unlike larger evaluative instruments that specify very detailed criteria, LORI is founded on broadly interpreted dimensions intended to support summative discourse of an object's strengths and weaknesses. This heuristic approach to evaluation is not unique. Nielsen (1994), for example, synthesized a manageable set of guidelines for evaluation of software usability, and Hedberg (2004) defined seven discourses in multimedia design. LORI's dimensions are manifested by the nine items listed in Table 1.

Table 1. Items in LORI 1.5 (Nesbit, Belfer, & Leacock, 2004).

Item	Brief Description
Content quality	Veracity, accuracy, balanced presentation of ideas, and appropriate level of detail
Learning goal alignment	Alignment among learning goals, activities, assessments, and learner characteristics
Feedback and adaptation	Adaptive content or feedback driven by differential learner input or learner modeling
Motivation	Ability to motivate and interest an identified population of learners
Presentation design	Design of visual and auditory information for enhanced learning and efficient mental processing
Interaction usability	Ease of navigation, predictability of the user interface, and the quality of the interface help features
Accessibility	Design of controls and presentation formats to accommodate disabled and mobile learners
Reusability	Ability to use in varying learning contexts and with learners from different backgrounds
Standards compliance	Adherence to international standards and specifications

In the following sections, we outline research and practices bearing on the nine LORI items and describe how each item is interpreted to evaluate multimedia learning resources. We conclude by discussing some of the larger implications of evaluation in online learning object communities and the benefits of developing a standardized, heuristic evaluation system to meet the changing demands of quality assurance and quality improvement for learning resources.

Content quality

Content quality is perhaps the most salient aspect of learning object quality and certainly the one most relevant to the expertise of subject matter experts. A learning resource is of little or no use if it is well designed in all other respects but its content is inaccurate or misleading. Indeed, in some approaches to learning object evaluation, quality is defined largely on content-related criteria. For example, MERLOT's general evaluation standards divide quality into three parts: content validity, potential effectiveness as a teaching-learning tool, and ease of use (MERLOT, 2000).

For learning materials in any medium, the importance of clear, unbiased, and accurate content is often taken to be so obvious that the detrimental effects of poor content quality are rarely analyzed. Mikk (2002), however, explained the value of conducting empirical research to measure both content quality and the impact of its absence. While his work focused on the assessment of quality in textbooks, it is equally relevant to content quality in other learning materials, including multimedia learning resources.

Sanger and Greenbowe (1999) and Dall'Alba et al. (1993) present two approaches to examining the impact that errors and biases in science textbooks have on learner understanding of course concepts. Both studies found many examples of unintentional biases in the way concepts were portrayed in the textbooks. Further, they found that learners' "understandings are incomplete in ways that parallel misleading or inaccurate textbook treatments" (Dall'Alba et al., 1993 p. 622). Often the gaps in learners' knowledge are not immediately obvious, as evaluation materials are likely to mirror the materials students are learning from. For these reasons, careful attention to content quality is particularly important.

The problem may be even more of an issue in the area of learning objects. Almost 15 years ago, de Laurentiis (1993) warned that content is often incomplete in computer-based educational materials and that this is a key factor in making learning more difficult. More recently, Hill and Hannafin (2001) observed that learning resources often suffer from lack of regulation of content validity, reliability, and credibility. We anticipate that clear and widely accepted evaluation rubrics will help potential users identify objects that do achieve high content quality standards.

To this end, both learning object developers and evaluators should take special care to consider what assumptions are implicit in learning materials and how the novice is likely to interpret the content. Gollnick and Chinn (1991), for example, identified six forms of bias that are often present in learning materials: invisibility, stereotyping, selectivity and imbalance, unreality, fragmentation and isolation, and language bias. Being aware of the types of bias that can affect content quality is an essential step towards addressing these issues.

When rating content quality using LORI, the reviewer should consider an object that is unusable as a result of serious inaccuracies, biases, or omissions to warrant a rating of 1. An object that contains accurate information presented at the right level of detail in a balanced manner, but that omits or de-emphasizes some key points in a way that could mislead learners would receive a rating of 3. Finally, an object that is free of error, bias, and omissions, that provides evidence to support claims, and that emphasizes key points with sensitivity to cultural and ethnic differences using an appropriate level of detail would receive a rating of 5.

Learning goal alignment

As evaluators of instructor-designed university courses, we have frequently found substantial mismatches between learning and assessment activities, most notably instances where students were tested on concepts and procedures that were only distantly related to the course's learning activities and presentations. According to a review by Cohen (1987), improving instructional alignment between teaching and testing in teacher-designed materials can boost student achievement from 1 to 3 standard deviations.

The problem of alignment at the course and program levels is gaining recognition (Liebling, 1997; Porter, 2002; Roach, Elliott, & Webb, 2000), and educators and administrators have several well-developed models to choose from when assessing the alignment between school programs and district, regional, or national standards (Ananda, 2003; Rothman, Slattery, Vraneck, & Resnick, 2002; Webb, Alt, Cormier, & Vesperman, 2006). However, the approaches used to assess alignment at the broad curricular level require a significant investment of time (Porter, 2002), so they are not appropriate for the smaller chunk sizes of most learning objects.

The learning goal alignment item in LORI provides a more efficient heuristic approach suitable for self-contained digital resources at a moderate level of granularity, that is, resources that are smaller than courses but large enough to contain a combination of content, learning activities, and assessments. This LORI item emphasizes the crucial role that goal-driven design plays in quality. We believe that developers should explicitly state the learning goals for an object, either within the content accessible to the student or in metadata available to the instructor (Metros, 2005). Explicit goals help the instructor to make the initial decision on whether an object is likely to be relevant to, and appropriate for, a specific context. Further, the learning activities should be aligned with the stated goals (Hodson, 2001). To complete the alignment triangle, the activities should be sufficient to provide learners with the knowledge and skills to be successful in the assessments, and the assessments should measure student achievement of the learning goals.

A learning object with a substantial mismatch among assessments and learning activities, such that the object is unusable, would receive a rating of 1. An object with clearly stated learning goals and a substantial yet incomplete match between those goals and the assessment activities would typically receive a rating of 3. To earn a rating of 5, an object must specify learning goals within the content or its associated metadata, provide content and activities appropriate to the goals and intended audience level, and include goal-relevant learner assessments.

Feedback and adaptation

Generating effective feedback and adapting to learner characteristics have been understood as important goals for educational technology since at least the early 1960s (Park, 1996). These goals are in part motivated by the belief, famously presented by Bloom (1984), that adaptive teaching strategies are the key to reproducing the very high achievement levels obtained with one-to-one tutoring. Feedback and adaptation are also important features of open-ended learning environments featuring simulations and microworlds.

Feedback is a limited form of adaptation in which the object presents information in relation to a localized action of the learner. More powerful forms of adaptation use comprehensive information about the learner such as performance history, measures of aptitude, or self-reports of preference, aptitude, or mental state to individualize the learning environment. Adaptive materials have been designed to adjust parameters such as the number of examples presented in interrogatory or expository format during concept learning (Tennyson & Christensen, 1988), the number of problems to be solved in learning LISP programming (Anderson, Corbett, Koedinger, & Pelletier, 1995), and the number and difficulty of test items (Wainer, 2000). Adaptive materials have provided individualized coaching or scaffolding for learning computer-game strategies (Goldstein, 1982), scientific modeling (Jackson, Krajcik, & Soloway, 1998), ecology (du Boulay & Luckin, 2001; Luckin & du Boulay, 1999), self-regulation of studying (Hadwin & Winne, 2001), and many other domains. Unfortunately, very few of these adaptive resources have been made available to teachers and students outside the research projects for which they were constructed.

Limited forms of feedback, such as those often used in rote learning materials, have been demonstrated to benefit post-test scores relative to no-feedback control conditions (Morrison, Ross, Gopalakrishna, & Casey, 1995; Bangert-Drowns, Kulik, Kulik, & Morgan, 1991). Compared to feedback messages that simply present correct solutions, verbal messages crafted to concisely explain the causes of specific types of error have been found to increase post-test performance and decrease learning time (McKendree, 1990). We extend the concept of explanatory feedback beyond verbal messages to include simulations or microworlds, in which the program responds to a learner's actions in a way that reveals the underlying principles of the represented phenomenon. For example in the SimCity urban planning simulation environment, road traffic and pollution increase after the learner builds a suburban infrastructure (SimCity, n.d.).

Resources at the highest level of adaptation maintain a model of the learner that offers a principled basis for guiding adaptations. For example, the LISP tutor developed by Anderson, Corbett, Koedinger, and Pelletier (1995) models the domain of LISP programming as a set of production rules. The learner model, which estimates the probability that each rule has been learned, is used to individualize the amount of practice in each section of the curriculum to ensure that the learner sufficiently masters specific production rules before proceeding to the following section. Luckin's Ecolab (Luckin & du Boulay, 1999), another example of theory-based adaptation, combines a learner model with Vygotskian principles of learning support to individualize the level of assistance, difficulty of task, and complexity of the environment.

Some learning resources provide options that allow learners to customize the behavior of the resource. For example in Emile, an environment for learning kinematics (Guzdial, 1994), learners are able to select the level of instructional support they receive. An important question for learning object evaluators is whether a particular learner control feature constitutes effective adaptation to the learners' needs. The mixed research record on learner control offers little guidance in this respect except to indicate that learners make better decisions about their learning when provided with relevant information or advice (Williams, 1996; Eom & Reiser, 2000). While theories of self-regulated learning suggest that well-designed learner control features can promote metacognitive engagement (Hadwin & Winne, 2001), there is evidence that many students are unable to accurately self-monitor progress toward learning goals (Zimmerman, 1998) or their need for assistance (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003). For these reasons we argue that learner control features should only be regarded as adaptive if it is plausible that learners are well enough informed to use them effectively.

For this LORI item, an object that is essentially expository and provides little or no feedback receives a rating of 1. An object that consistently explains why a response is incorrect or demonstrates the entailments of actions in a constructivist environment might be assigned a rating of at least 3. A learning object that provides such feedback and builds a learner model to individualize the learning activities and environment would earn a rating of 5.

Motivation

The motivational quality of a learning object affects the amount of effort a learner will be willing to invest in working with and learning from the object. Expectancy-value theory (Wigfield & Eccles, 2000) offers a useful framework for understanding issues of learner motivation. According to expectancy-value theory, motivation is a function of the value one places on a task, one's expectations about the task, and the perceived cost of the task. For example, tasks that are inherently enjoyable will have high intrinsic value, and those that help a learner to achieve more distal goals such as passing a course will have high utility value; both types of value will increase motivation. Learners' expectations about success or failure on a task will also impact motivation, as will perceptions of what the learner must give up (e.g., lost opportunities to do other tasks or effort expended to complete the task at hand). A learning object that is perceived to be too difficult or too easy may result in low motivation because learners expect it to be boring, not possible to complete, or not worth completing.

Multimedia-heavy interfaces are sometimes introduced in an attempt to bolster learner motivation, but such interfaces may squander and misdirect cognitive resources if their use is not integral to the learning goals of the resource (Mandel, 2002; Squires & Preece, 1999). Squires and Preece (1999) use the term superficial complexity to describe attention-grabbing gimmicks such as flashing banners, non-instructional animated characters, and irrelevant audio-tracks. These devices can initially capture a learner's attention, but their use in learning objects rarely leads to substantive motivational benefit. As their novelty dissipates, they soon become distractions that interfere with learning (Garris, Ahlers, & Driskell, 2002). Instead, developers should focus on aspects of learning objects that can be designed to foster intrinsic motivation, which Ryan and Deci describe as a "natural wellspring of learning and achievement" (2000, p. 55).

Gaining and retaining attention by presenting highly relevant material and authentic activities that are meaningful to learners are two approaches that can increase intrinsic motivation (Keller, 1987; Keller & Suzuki, 2004; Schraw, Flowerday, & Lehman, 2001). Objects that allow learners some control over their own activities and learning (Martens, Gulikers, & Bastiaens, 2004), that provide opportunities for high levels of interactivity and encourage learner participation (Tsui & Treagust, 2004), and that present game-like challenges (Garris, Ahlers, & Driskell, 2002) will have high motivational value. Objects that partition content into discrete components or levels matched to the ability of the learner lead to increased self-efficacy and motivation (Keller & Suzuki, 2004). Finally, the multimedia possibilities afforded by learning objects, which help learners to visualize complex information and processes, have also been shown to increase student motivation (Tsui & Treagust, 2004).

In the LORI rubric for motivation, a learning object that is not relevant to a learner's goals, that is too easy or too difficult for its intended level, or that seeks to draw attention primarily through superficial complexity would receive a score of 1. An object that provides sufficient interaction to hold learners' attention as they work through the content but that is not designed to build confidence or help the learners to see the relevance of what they are learning would receive a rating of 3. An object that is perceived as relevant by its target audience, that offers appropriate difficulty levels for learners to gain confidence and satisfaction from the learning activities, and that is able to get and hold learners' attention would receive a rating of 5.

Presentation Design

In LORI, presentation design refers to the quality of exposition in a digital resource. This item applies to all expository media including text, diagrams, audio, video, and animations. High-quality presentations incorporate aesthetics, production values, and design of instructional messages in ways that are consistent with principles from research and theory in cognitive psychology and multimedia learning (Mayer & Moreno, 2003; Parrish, 2004) and with established conventions for multimedia design (e.g., Pearson & van Schaik, 2003). The essence of the presentation design item is represented by the principles of clear and concise expression advocated by Tufte (1997) for data graphics and Strunk (Strunk, Osgood, & Angell, 2000) for writing style.

Much of the science behind presentation design follows from the properties of human working memory, as addressed in cognitive load theory (CLT) and Mayer's principles of design for multimedia learning (Mayer, 2001; Mayer & Moreno, 2003; Reed, 2006; van Merrienboer & Sweller, 2005). In CLT, intrinsic cognitive load is described as being an inherent part of the learning task that results from the interactivity among the elements of to-be-learned material; this component of cognitive load cannot be reduced without impacting the learning objectives (Mayer & Moreno). Designers have more flexibility over two other components of cognitive load. Effective presentation design can increase germane cognitive load, which can contribute to learning and schema development. Poor presentation design can lead to increased extraneous cognitive load, which will reduce the capacity available for other cognitive processing. Mayer's design principles form an effective guide to minimizing extraneous cognitive load. They include coherence principles that recommend excluding unneeded or irrelevant materials, contiguity principles that recommend presenting elements that the learner must mentally integrate close together in space and time, and a modality principle that recommends explaining animations with audio narration rather than text. Consistent with Mayer's modality principle, there is strong evidence that, in comparison with text-only formats, displays that combine graphics with text often greatly benefit learning (Vekiri, 2002).

The advantages of graphic representations for representing verbal concepts, as distinct from their more obvious uses in presenting inherently spatial information, are also becoming better understood by researchers and designers. Knowledge maps, consisting of concept nodes connected by links labeled with relational terms, have been shown to work as powerful adjuncts or alternatives to expository text (Lambiotte, Dansereau, Cross, & Reynolds, 1989; Hall, Hall, & Saling, 1999; Nesbit & Adesope, 2006). Evaluators should question whether learning resources make the best use of text, conceptual diagrams, audio, and other formats to effectively communicate verbal concepts.

For rating learning objects on this item, we suggest that objects suffering from problems such as illegible fonts, distracting colour schemes, or poor audio or video should receive a rating of 1. Objects showing professional presentation design that is concise, clear, and aesthetically pleasing should receive a rating of at least 3. To obtain higher ratings, objects should also demonstrate designs that effectively integrate text, graphical, video, or audio media in a manner that is appropriate for the content and consistent with research-based principles of multimedia learning.

Interaction Usability

Usability has long been recognized as a critical issue in software quality (e.g., Norman, 1998; Nielsen, 1994) and in educational software in particular (Tselios, Avouris, Dimitracopoulou, & Daskakaki, 2001). Typically, usability efforts focus on error prevention, yet instructional activities are often designed to encourage students to make and learn from mistakes (Lohr, 2000). This tension between the demands of good usability and the demands of effective instructional design can be resolved by clearly distinguishing between two types of interactions that occur when a student uses a learning object: interaction with the interface and interaction with the content. In LORI, *interaction usability* is the term used to describe how easy or difficult it is for learners to move around in a learning object — to navigate their way through the options that the object provides and to participate in the activities the object offers. Other LORI items (e.g., feedback and adaptation) focus on interaction with the content, per se. Because learners must split limited cognitive resources across these two types of interaction, designers should strive to ensure that interaction with the interface will not get in the way of learning and that any errors the learner makes will be related to meeting the learning goals of the object, not to navigation (Laurillard, Stratfold, Luckin, Plowman, & Taylor, 2000; Mayes & Fowler, 1999; Parlangeli, Marchigiani, & Bagnara, 1999; Squires & Preece, 1999).

To reduce the effort learners must invest in learning and manipulating the interface, usable designs build on learners' prior knowledge of common interface patterns and symbols and require recognition, rather than recall, in navigational tasks. A learning object that rates highly in interaction usability will present a clear conceptual model that provides consistency in presentations and outcomes and simple mappings between actions and results, and it will implicitly inform users how to interact with it without overloading them with extraneous information (Mandel, 2002). While a learning object should allow the learner some flexibility in how to proceed through activities, it is critical to recognize that a certain amount of consistency in layout and structure can actually lead to more effective individualized explorations (Fleming & Levie, 1998; Kearsley, 1988; Tognazzini, 2001).

In cases where navigational information cannot be conveyed implicitly, the learning object should provide clear instructions and user interface help, allowing the learner to quickly grasp the directions and return to the content (Kearsley, 1988). According to Ryder and Wilson (1996), users see the computer — or in our context, the learning object being presented via the computer — as their partner in a conversation. In keeping with the norms of conversation (Grice, 1975), instructions should say true things (quality); they should say neither too much nor too little (quantity); they should be relevant to the topic at hand; and they should be clear. Thus, a learning object that is high in interaction usability will have easy-to-follow directions available at all points where a learner may need such help.

Delay is another important factor in interaction usability. The generally recognized maximum acceptable delay for web-page loading is 10 seconds (e.g., Nielsen, 1997; Ramsay, Barbesi, & Preece, 1998). However, Mayhew (1992) provides a figure of two seconds for intermediate steps in a process, and moving from one task to the next within a learning object would be seen by most users as an intermediate step. These numbers can be expected to drop, as more users come to rely on high bandwidth connections and faster machines. If a step within a learning object takes too long too load, learners will experience frustration and may choose to exit the object (Selvidge, Chaparro, & Bender, 2001).

Using LORI, objects that lack interactivity or have problems with navigation due to high cognitive load, poor screen layout, broken links, or inconsistencies in system response would receive a 1. Objects which contain working interactive elements but pose some problems for learners attempting to learn the interface would typically receive a 3. To earn a 5 in interaction usability, navigation through the object must be intuitive, predictable, and responsive.

Accessibility

People with disabilities may be inadvertently excluded from the potential benefits of online learning if learning object developers do not consider and accommodate issues of accessibility in the design of learning objects. Paciello (2000, Preface: Who are you?) claims that the increasing prevalence of graphical user interfaces has produced a situation in which "blind users find the Web increasingly difficult to access, navigate, and interpret. People who are deaf and hard of hearing are served Web content that includes audio but does not contain captioning or text transcripts." While these comments reference the web in general they are equally applicable to web-based learning objects. They correspond to a widespread disregard for accessibility among developers of educational software. A survey of major providers of instructional software (Golden, 2002) found that none of the 19 companies responding to the survey provided accessible products, and only 2 companies were enacting plans to address accessibility issues in product development and marketing.

Learning objects that present content only in text or graphical formats, with no audio voice-over, may exclude learners with visual impairments; objects that are designed specifically for students with ADHD may be ineffective for autistic learners (Kalyanpur & Kirmani, 2005). As Palmeri (2006) notes, good design should provide multiple means of accessing educational content. In some countries accessibility is being fostered through public policy. In the United States of America, for example, Section 508 of the *Rehabilitation Act* requires that federal agencies make their information technologies accessible to people with disabilities. Section 508 provides a detailed set of standards for ensuring that reasonable and effective accommodations are provided. The standards for web content, for example, include the requirement that "when pages utilize scripting languages to display content … the information provided by the script shall be identified with functional text that can be read by assistive technology" (Section 508 Standards, 1998). The 2004 *Individuals with Disabilities Education Improvement Act* imposes similar responsibilities on educators by requiring materials to be made accessible to learners with mild disabilities (Peterson-Karlan & Parette, 2005).

At the international level, accessibility is being advanced by the 14 Web Content Accessibility Guidelines established by the W3C (World Wide Web Consortium, 1999). A central theme in W3C accessibility is "graceful transformation," that is, the ability of a web page to offer consistent meaning when users interact with it through a wide range of browsers, screen types, assistive technologies, and input devices. Each of the W3C guidelines includes a set of checkpoints, and each checkpoint is categorized as Priority Level 1, 2, or 3. Conformance to the guidelines is then determined by whether the checkpoints at each priority level have been met.

More recently, the IMS Global Learning Consortium has provided *Guidelines for Developing Accessible Learning Applications* (IMS, 2002). In dealing specifically with online learning, these guidelines address accessibility issues in tests, interactive exercises, presentation tools, repositories, schedule organizers, threaded message boards, and synchronous collaboration tools such as text chat and video conferencing. They recommend the use of standard technical formats, especially W3C's Extensible Hypertext Markup Language (XHTML).

Accessibility evaluation for LORI requires a detailed understanding of the W3C and IMS guidelines. LORI ratings are closely tied to the scores objects would receive if evaluated on standard accessibility metrics. In the case of web pages, we recommend that evaluators who are not experts in this area use one of the validation services, such as WebXACT (http://webxact.watchfire.com), A-Prompt (http://aprompt.snow.utoronto.ca), or UsableNet (www.usablenet.com), that automatically checks for conformance to the W3C accessibility guidelines and returns a report on the level of compliance. Learning objects that contain Flash, Java, and other media or plug-ins must be manually checked, meaning that evaluators not yet familiar with this area may choose to mark the item as Not Applicable. For non-web-based objects, we recommend that evaluators interact with materials using assistive technologies, and base ratings and comments on IMS guidelines. Ratings can be calibrated using equivalent or similar W3C requirements.

Reusability

A key benefit of developing learning objects is the potential for reuse across courses and contexts (Harden, 2005; Hirumi, 2005; Koppi, Bogle, & Bogle, 2005). The possibility of creating digital learning objects that are more granular and more adaptive to different contexts and learner needs than conventional materials increases the opportunities for reuse. The ESCOT project is one example of a successful project that has made reusability a priority (Roschelle & DiGiano, 2004). While their primary definition of reusability focused on using existing materials to create their objects ("curriculets"), they also note that, once developed, curriculets "could be used by teachers in many different ways [including]… a computer lab exercise … whole class discussion … [or] the basis for [a] whole curriculum" (80–81).

The LORI reusability item focuses on a practical definition of reusability that will help to make the issues and approaches to reusability more salient to learning object developers and users. We hope that this, in turn, will help to promote the development of more portable learning objects, thus furthering one of the main goals of the learning object enterprise — reduction in the duplication of effort and cost across institutions. The LORI rubric values learning objects that are effective for a broad range of learners, but recognizes that no single learning object will be effective for all learners in all contexts.

At the most basic level, learning objects should not contain reference to specific contextual information such as instructor names, class locations, or course dates; this information should be housed in the overall course structure. Going beyond this fundamental requirement, designing reusable learning objects demands a thoughtful balance between reusability and fit to context, or as Campbell (2003, p. 38) puts it, "learning objects need to be produced in such a way that they are large enough to make sense educationally, but small enough to be flexibly reused." Certainly designers must keep the needs of learners in their target context in mind when developing new learning objects. However, this also includes considering the needs of diverse learners in that context — those with different backgrounds, abilities, and disabilities. For example, providing a glossary of key terms or a summary of some of the prerequisite knowledge that students should already have in order to complete the current learning object makes the object more accessible for those who might be coming to it from a learning path quite different from the one envisioned by the original object developer. Designing for a diverse population will make it more likely that the learning object will be reusable in a range of contexts (Treviranus & Brewer, 2003).

The LORI rubric for reusability describes some of the approaches that learning object developers can take to maximize reusability without sacrificing usefulness. An object containing instance-specific information, such as assignment due dates, would typically receive a rating of 1. An object that has restricted reusability due, for example, to reliance on specific prior knowledge that is not accessible via adjunctive content would receive an intermediate rating. An object that embeds sufficient situational context to be meaningful, provides adjunctive or alternate content useful to learners of varying skills and abilities, and is usable in multiple contexts would earn a rating of 5.

Standards compliance

"The requirement for standards is incontrovertible. From baseballs to railroad tracks, standard dimensions and approaches to design are essential if the cogs of today's technological world are to intermesh" (Bush, 2002, p. 5). The standards-compliance item in LORI addresses relevant technical standards and specifications, including those for HTML and XML (World Wide Web Consortium, 2006), object interoperability (IMS, 2006), and packaging (SCORM, see Advanced Distributed Learning, 2003). In the context of learning objects, the primary thrust of standardization efforts has been in the area of metadata — a term used to describe data about the learning objects. It is this metadata that potential users search when looking for learning objects, yet there are often discrepancies in approaches to metadata across objects and repositories. Different names may be used for the same element (e.g., "author" vs. "creator"), the same name may be used for different elements (e.g., "date" may refer to the date an object was created or the date that it was last updated), and elements used in one repository may simply have no correlate in other repositories. Even when a consistent metadata template is used, there can be variation in the quality of the information entered into each field. Some fields may be left blank or only partially completed due to lack of time, interest, or understanding on the part of the person entering the metadata (Krull, Mallinson, & Sewry, 2006). All of these issues directly impact the searchability and reusability of learning objects.

Achieving consistent and effective use of metadata standards is critical to overcoming the technical barriers to learning object reusability (Duval & Hodgins, 2006; McClelland, 2003). The quality of the metadata description and how closely it matches the learning object's characteristics are key factors in helping users "evolve from searching to finding" (Duval & Hodgins, 2006, p. 97). As the number of learning objects continues to grow, the importance of functional, sharable, and consistent metadata grows as well. With consistent usage of standardized metadata schemes, the interoperability of learning object repositories will increase significantly (Robson, 2004). According to Sampson & Karampiperis (2004), with consistent metadata, "*searching* becomes more specific and in-depth; *managing* becomes simpler and uniform; and *sharing* becomes more efficient and accurate" (p. 207).

There are several organizations involved in the development of usable metadata standards (CanCore, see Friesen & Fisher, 2003; DublinCore, 1999; IEEE, 2002; IMS, 2002 & 2005; and SCORM, see Advanced Distributed Learning, 2003, for examples). These agencies must balance the need for thorough descriptions of learning objects (e.g., the IMS standards include approximately 70 separate elements) with realistic time expectations for data entry. Too few elements and the metadata won't be effective in aiding learning object discovery even when complete. Too many elements and fields will be left empty, which will also defeat the goal of making the objects accessible and reusable through searches.

Evaluators using the standards compliance item in LORI as part of their assessment of the quality of a learning object should examine whether the metadata fields associated with the learning object follow the international standards and whether the creator has completed them with sufficient detail and accuracy to enable others to use the information to assess the relevance of the learning object. Objects that fail W3C and SCORM compliance tests or that do not provide sufficient metadata would receive a rating of 1. Those that pass some of the compliance tests would receive an intermediate rating, depending on the level of compliance. To receive a rating of 5 in standards compliance, an object must adhere to all relevant standards and specifications and must have metadata that is available to users.

Conclusion

In the preceding sections, we have described each of the nine items that make up the learning object review instrument and reviewed arguments and evidence that support the centrality of these categories in considerations of learning object quality. Outside this review, the utility of LORI has been examined in empirical work (e.g., Leacock, Richards, & Nesbit, 2004; Li, Nesbit, & Richards, 2006; Richards & Nesbit, 2004). These studies demonstrate that LORI is useful within a collaborative evaluation model and, when used in an educational setting, is perceived as helping participants to acquire instructional design and development skills.

Methods for assuring quality in learning resources are changing. The traditional labor- and time-intensive approaches, such as pre-publication expert peer review, are routinely bypassed as publishing and data-sharing technologies enable individuals to share their work directly with wide audiences. As with any emerging social practice, development brings standards, conventions, and new traditions. We believe that heuristic approaches to evaluation and quality control will form an important part of these new traditions.

The time required to use some of the more highly detailed approaches to evaluation is a significant barrier to their implementation (Jones et al., 1999). LORI strikes a pragmatic balance between depth of assessment and time. With a few minutes of effort, an evaluator can provide a meaningful learning object review that will be informative on its own and can also be aggregated with the reviews of others who have evaluated the same object.

Although some evaluators may initially not be comfortable using every item in LORI, the heuristic approach helps ensure that almost all experienced designers and users of learning resources can use the instrument effectively. Our experience is that most evaluators become comfortable with LORI items after rating a few learning objects. Further, compared with instruments that present more detailed criteria, LORI's relatively open structure better affords collaborative evaluation through discussion and argumentation. This characteristic is important in growing and sustaining shared knowledge among developers and users of multimedia learning resources.

It may seem that very few of the learning objects that many of us have encountered would earn top ratings in LORI. In these early days of improving knowledge and developing conventions around learning object quality this is to be expected. Without clear benchmarks, it is difficult for new developers to know how to ensure that their objects will be of high quality. Clear, visible guidelines for assessing quality will help both users and developers in this emerging field. With time, and with the wide adoption of evaluation tools such as LORI, we believe a greater proportion of learning objects will earn top ratings.

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Minimum Indicators to Assure Quality of LMS-supported Blended Learning

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ABSTRACT

This study describes a set of institutional indicators that suggest minimum standards for the quality assurance of learning supported by learning management systems in blended contexts. The indicators are evaluated by comparing seven universities that use a common learning management system to support student learning experiences. The responses to a qualitative questionnaire provide evidence of how the participating universities approach leadership, policy making, development, and evaluation as they relate to the quality assurance of learning management systems. A comparison among the universities reveals that they tend to have a better understanding of technical rather than educational issues related to quality assurance. A case is made for the need for universities to address key areas in order to reliably assure the quality of learning supported by learning management systems.

Keywords

Quality assurance, Learning management system, Leadership, Policy, Staff development, Evaluation

Introduction

University student learning experiences continue to be influenced by the way teachers integrate information and communication technologies (ICTs) into course design. No longer is the use of ICTs that facilitate distance learning restricted to universities that have a mission to educate at a distance. The affordances provided by technologies are encouraging even campus-based universities to systematically invest in ICTs to enhance the student experience. The implications of this for ensuring the quality of the student learning experience are serious and complex. How can we assess the relationship of ICTs and the student learning experience? This is a difficult question, particularly because ICTs are often used to complement learning experiences in which a significant amount of face-to-face learning occurs.

One of the first difficulties in trying to improve student learning through the use of ICTs is agreeing upon how to talk about the subject. What is meant by the term “ICTs”? What is the focus of research on learning when ICTs are used to support part of the experience? How can we assess the relationship between face-to-face learning and learning supported by ICTs? This last question includes an increasingly common realisation of ICTs in the student experience of learning at university. The use of an online learning management system such as WebCT, Blackboard, or dotLRN to support campus-based learning experiences is an increasingly widespread international phenomenon in higher education. A brief search of leading journals on research in higher education and national websites responsible for teaching and learning, such as the Higher Education Academy in Great Britain and Educause in America, offers evidence of the frequency of this type of learning situation.

Over the last five years, a significant number of universities across Germany, Spain, Central America, and Australia have begun to use dotLRN as to complement the face-to-face experiences of students. DotLRN is an open-source learning management system containing number of ICTs (Calvo, Ghiglione, & Ellis, 2003). These include presentation tools (WimpyPoint, Wiki, blog), assessment tools (a QTI-compliant environment), communication tools (forums, chatrooms, video conferencing), and management tools such as Curriculum Central (Turani, 2006).

In this study, we consider the use of dotLRN to support the blended learning experiences of thousands of students across seven universities. Similar concerns for the quality assurance of student learning supported by dotLRN among the participating universities motivated intra-institutional discussions. The discussions led to an agreement to investigate the minimum set of indicators for assuring the quality of learning supported by a learning management system (LMS).

The structure of the study is as follows: The background introduces terminology and the prior research that supports the model and research methodology. The next section discusses six necessary but insufficient indicators for the quality assurance of learning supported by LMSs in blended learning contexts. Then the study's participants and the methods and questionnaires used are described. The article concludes with a discussion of the limitations, findings, and implications of the study.

Background

The use of ICTs in universities often requires the use of a range of terminologies, the meanings of which are often dependent on the context in which they are used. The following definitions are adopted in this study to try to reduce ambiguity.

- *Learning management systems* are software systems designed to support student learning. They contain a number of presentation, assessment, communication, and management tools, for example, dotLRN, WebCT, and Blackboard.
- *E-learning* is defined as the use of ICTs to help students learn (HEFCE, 2005).
- *Blended learning* in this study is defined as a systematic mix of e-learning and learning in face-to-face contexts, in which coherence across the two contexts from a student perspective is achieved by focusing on the same intended learning outcomes.
- *Enterprise level issues* are those issues that concern most faculties. They are addressed at the university level.

The definitions of some terms require more explanation. One such term is *quality assurance* (QA). Quality assurance in higher education is a complex issue. In industrially orientated models of quality assurance, QA outcomes can be relatively straightforward, such as the quantity or fitness for purpose of a particular product produced in a certain way. In contrast, many of the outcomes of a higher education experience are often ephemeral, or at least not realised for many years, and are difficult to measure.

Quality assurance in higher education cannot simply focus on the *what*, such as the quality of graduates (however measured), or the quantity of employed graduates at a point in time. For one thing, there is no single measure of the quality of a graduate. A focus on quantitative measures, such as the number of employed graduates, is insufficiently descriptive to indicate *how* they developed their attributes sufficiently to make them employable. One of the shortcomings of using only outcomes-based indicators for quality assurance is that they are often not very useful for improving the (often complex) processes that lead to desirable outcomes. In a sense, if we do not understand the educational processes leading to the outcomes we are looking for, then we do not have a basis for evaluating them. Without that, it is difficult, if not impossible, to improve the quality of the outcomes we seek. Consequently, a key characteristic of models for quality assurance in higher education is a focus on the process. Improvement of process is one of the key principles underpinning models of quality assurance for higher education, such as the transformative model (Harvey & Knight, 1996), the university of learning model (Bowden & Marton, 1998) and the prospective model (Biggs, 2001).

Extensive and systematic research over 30 years has identified that the quality of student learning is associated with what students think they are learning, how they approach their learning, and how they perceive their learning context. Research has also shown that this is related to how teachers perceive of student learning, how they conceive of teaching, and how they approach the learning and teaching experience. Some key outcomes from this research suggest:

- Not all students experience the intended learning outcomes that teachers prepare in the same way (Biggs, 2003; Prosser & Trigwell, 1999);
- The quality of learning is closely associated to what students think they are learning and how they approach their studies (Marton & Booth, 1997; Ramsden, 2002);
- The quality of the student experience is related to teacher-adopted variations in approaches to teaching (Prosser & Trigwell, 1999);
- The quality of learning can be assessed by closed-ended instrumentation at the end of a student's course. For example, the course-experience questionnaire and student-experience questionnaires (Ramsden, 1991; Prosser & Trigwell, 1999).

The trialing and evaluation aspects of the course development and teaching processes present a significant challenge to universities that are looking to roll out the use of ICTs across hundreds if not thousands of courses supporting tens of thousands of students. In some ways, the enterprise-level issues for universities seeking to assure the quality of learning that arises from ICTs are to determine what those QA processes look like when QA strategies at the course level are aggregated upward to the institutional level.

Another more recent body of research helps to conceptualise what happens to the quality assurance processes for ICTs when they are aggregated across thousands of courses supporting tens of thousands of students. This area of research is often referred to as benchmarking e-learning. In the New Zealand higher education context, a maturity model of e-learning use has been developed (Marshall, 2005). Drawing on earlier research (Chickering & Gamson, 1987; IHEP, 2000) we divided e-learning into key process areas: learning, development, coordination and support, and evaluation. Using descriptors for each process area, we were able to assess the maturity of a university using e-learning to support learning. In the United Kingdom, the Higher Education Academy is sponsoring an e-learning benchmarking program. One approach to benchmarking e-learning among universities involves the use of a "pick and mix" tool. This is a list of 18 factors that represent dimensions of activity related to e-learning (Bacsich, 2005a; 2005b). Universities wishing to benchmark with each other can choose some of these factors and then engage in comparative descriptions (and some metrics, where possible) of how well they are faring. Examples of the 18 factors include the stage of development of the learning management system (or virtual learning environment) in the institution, ranging from no LMS to one LMS, and the stage of recognition of the workloads involved in using e-learning, ranging from no recognition to full activity-based cost recognition of workload. Research programs in both New Zealand and the United Kingdom offered some insight into the participating universities of this study regarding high level issues for assuring the quality of learning when an LMS such as dotLRN is used.

Improving processes: embedding ICTs in course design

This study uses course development and teaching processes as a way of thinking about how to improve the use of ICTs in the university student experience. The process described in Table 1 below has been chosen for a number of reasons:

- It identifies key stages and decision-making involved when integrating ICTs into the course design and teaching;
- The identification of the key stages allows an understanding of practical approaches to the quality assurance of the whole learning experience and the parts supported by ICTs at the course level;
- It facilitates talking about the integration of ICTs from a student perspective;
- It provides a way of focusing on the outcomes of the learning experience;
- Different theories of learning can be used to underpin the process.

When staff consider integrating ICTs into course design, it is possible, as Table 1 suggests, to conceive of the process in two broad parts: deciding/planning/developing/trialing and learning/teaching/evaluation.

Table 1 identifies a typical course development and teaching process (Ellis & Moore, 2006). If we consider this table at the level of the development of a single course, the parts of the process can be conceptualised in terms of five stages, representing the broad stages staff use when redeveloping courses with ICTs. When redeveloping courses with ICTs, not all staff go explicitly through each stage. Rather, these stages represent the scope of activities in which staff might engage. Before describing the stages, it should be noted that even though the stages have been separated for analytical purposes, in reality some are iterative and entwined. For example, designing, developing, and trialing are much more likely to be integrated and cyclical than linear, as the table suggests. In addition, the extent to which the process is student-centered is related to the learning activities chosen, the type of evaluative data collected, and the theory that underpins the evaluation instrument design.

Table 1. Examples of issues raised by introducing ICTs into course development and teaching processes.

No.	Stage	Related issues
5	evaluation	evaluation of the learning experience, evaluation of the development process
4	learning, teaching, assessment	student access, authentication, orientation and training, learning activities, teaching approaches, assessment
3	design, development, and trialing	balance of educational media, production, teamwork, staff development, prototyping, editing, trialing
2	the planning processes	curriculum issues (objectives, learning activities, assessment, outcomes, evaluation), resourcing issues, technology issues, feasibility, approval (faculty, university board)
1	the decision to develop or redevelop a course with ICT	purpose, relationship to other courses, feasibility, scope, student needs, consultation, university mission statement

In stage 1, staff begin by undertaking some sort of decision-making. Those initial decisions depend on the size and scope of the redevelopment or design of the course, the needs of students, the learning strategies of their department, and the culture of the institution. In stage 2, learning objectives and outcomes are used to give direction to educational and technological planning, learning activities, assessment, and the type(s) of educational media to be used. It is during the planning stages that key issues related to ICTs must be addressed in order to assure sustainability and quality: resourcing (a type of cost/benefit appraisal of the technologies and their usefulness in terms of the learning outcomes); feasibility (understanding the difference between what is desirable and what is feasible in terms of a university's readiness to support staff); and staff development (whether or not the teaching staff have sufficient skills to support students in ICT-based learning experiences).

For purposes of improvement, perhaps the most important quality-assurance process from a student perspective is the trialing that occurs during stage 3. At a minimum, it should be done before the curriculum materials are provided to students so that outcomes of the trial can be used to improve the quality of the resources.

In stage 4, students use ICT-supported resources, materials, and activities, to achieve their learning outcomes. A key aspect to help students at this stage of the process is to show them how to use the ICT-supported resources effectively to help them achieve their learning outcomes. Discussing the variety and nature of activities during this stage is beyond the scope of this study. For the sake of efficacy, we turn to an evaluation of the learning outcomes of stage 4 in stage 5.

For campus-based experiences of learning, where the ICT is supporting only part of the experience, evaluation is complex. The whole learning experience needs to be evaluated from a student perspective. If the quality of the ICT-supported part is also of interest, it needs to be evaluated in similar and consistent ways, for the sake of validity, and related to the whole. If such data are systematically and cyclically collected, the information can be used by staff to improve their understanding of the students' expectations and ratings of ICT as it supports the whole learning experience of a course.

Towards necessary but insufficient indicators

In discussions among the universities participating in this study, common themes arose that were related to sustaining the quality assurance of learning supported by LMSs in blended contexts. We based our summary of the key points on the experience of the participating universities and prior research. To have any chance of assuring the quality of learning activities supported by dotLRN, the combined experience of the participating universities suggests that there needs to be activity in the following six areas:

1. Leadership and ongoing funding

Modern universities, especially large universities, have multiple stakeholders who contribute to determining what a university claims to be. In conflict with this characteristic is a general trend toward fewer resources available for higher education. Without a sponsor to protect and advocate for ongoing funding for the use of ICTs in supporting quality student learning, sustained, quality-assured, and institution-wide support for ICTs would be unlikely to develop.

2. Policy

Policy formation goes to the heart of clarifying the culture of an institution. If there is no policy and planning for a particular area, one cannot realistically expect enduring and influential growth and change. This is particularly true for the quality assurance of ICTs when they are embedded in existing learning and teaching processes and systems, as opposed to when they stand as a discrete entity. For a university claiming quality assurance of ICTs in learning and teaching, a stated intention to support, enhance, augment, and elaborate the student learning experience through the use of ICTs should be evident in the university's strategic plan and operating policies if the quality assurance of ICTs in learning has any chance of being addressed.

3. Evaluation services

Evaluation of ICTs in learning for campus-based universities must focus on the whole learning experience if the evaluation outcomes are to relate meaningfully to a blended experience. Part of this evaluation service needs to consider how ICTs are used in the student learning experience and how their use contributes to the quality of the learning outcomes.

4. Support for teaching and learning with ICTs

If ICTs are used at the enterprise level to support student learning, then the ramifications of timely support of students and staff become serious. There is a range of strategies that are necessary to ensure the quality of learning when ICTs are used in the learning and teaching experiences. For example, when an LMS is used at the enterprise level, the QA strategies necessary include:

- backup and disaster recovery strategies for the LMS in case of computer failure;
- testing of the compatibility of platforms and browsers of an LMS;
- implementation of authentication services for users of the LMS;
- a rapid query-resolution process for technical issues raised by users of the LMS.

The quality-assurance issues are not restricted to the above, but also involve learning strategies such as:

- standards for orientation of student users in how to make the most of the resources on the LMS;
- a query-resolution process for learning issues raised by users of the LMS (For example, a helpdesk could be used to resolve both learning and technology issues);
- guidelines for the typical materials that students could expect on their subjects' web pages, which are published on the LMS. These guidelines could promote standards across all websites so that students can develop a set of sustainable expectations of how the LMS supports their learning across degree structures.

The point of listing some of these examples is not to create an exhaustive list of the issues that arise during learning when ICTs such as those found in LMSs are used to support students' experiences. Rather it is to underline the necessity of services and resources that are contingent on the scale of the ICTs being used by students across an institution.

5. Support for planning, design, and development with ICTs

Integrating ICTs into the student learning experience across a university requires appropriate knowledge and infrastructure, minimum standards of resourcing, and the time to engage in the design and development activity. Teachers who engage in these types of activities are often expected to fit them in around research and face-to-face teaching responsibilities, with little, if any, workload recognition for the time involved. Consequently, workload formulas or other workplace indicators should recognize in some way the time required to integrate ICTs into course design.

The scope of support for the planning, designing, developing, and trialing of ICTs in student learning is potentially endless. If an LMS is used at the enterprise level, its disaster recovery, technical robustness, and ongoing stability should be managed in such a way as to inspire confidence in the staff who invest significant time developing learning resources for students who depend on it. In addition, some sort of staff support for design and development issues should exist, such as either funds for small-project development or hands-on support from specialists with whatever necessary expertise is required (for images, texts, simulations, videos, etc.).

Resources for trialing ICTs that are aligned to the evaluation criteria of the whole learning experience are key aspects of ICT quality assurance. Course designers can use the outcomes of trialing, including user feedback, to tweak and adjust the resources before students use them. At this stage, it is necessary to ensure that the evaluation questions are not just about the technology, but about how ICT-supported resources help students achieve the learning outcomes that the materials have been designed to support.

6. The decision to develop or redevelop a course with ICT

Teachers should be able to access the university's vision or mission statements so that they will be able use ICTs to promote the university's strategic vision. This should be accompanied by a growing institutional and disciplinary understanding of which e-learning activities and materials are most appropriate and valuable for a school or department to develop and nurture.

University support and structures in the above six areas were thought to be worth investigating as emerging necessary but insufficient indicators that would need to exist within a university if it was, or was contemplating, supporting the quality assurance of ICTs in learning and teaching at the enterprise level.

Using these indicators as a way of comparison, how do the seven international universities supporting blended learning experiences measure up? The universities discussed in the study below all use the learning management system dotLRN to some extent. Some already use it as an enterprise system and some use it at departmental levels but may be contemplating its use at the enterprise level. Trialing the necessary but insufficient indicators described above, we investigated systems and structures in the participating universities in terms of their readiness for assuring the quality of learning supported by dotLRN.

Participants and methods used

The sample consists of seven universities that use dotLRN to support blended learning experiences at an institutional or departmental level. Cooperation in the project was achieved through a research interest common to the participating universities. One university is from Germany, one from Norway, two from Spain, two from Central America, and one from Australia. The responses are from both small and large universities. Table 2 provides a profile of the participating institutions.

Table 2. Universities surveyed for the project

University	Student numbers	Staff numbers	DotLRN users	DotLRN accounts	Expected user increases
Heidelberg	41,000	6,500	48,000	48,000	-
Valencia	54,000	3,000	30,000	30,000	+ 30,000
Galileo	40,000	300	20,000	20,000	+10,000
Bergen	17,000	3,500	16,000	40,000*	-
Nicaragua	10,000	N/A	1, 000	1000	-
Sydney	45,000	6,000	500	500	-
Carlos III	17,000	1,750	300	300	-

* dotLRN is used by staff as well as by students

Table 2 shows the universities that were surveyed as part of this project. All use dotLRN to some extent and all use it as a way of extending the face-to-face experience of students. Large numbers of students use dotLRN in the first four universities. The University of Heidelberg (http://www.uni-heidelberg.de) is Germany's oldest university, with a long tradition of educational innovation and openness. The University of Valencia (http://www.uv.es/~webuv/) offers competitive undergraduate, masters, and doctoral programs in a number of disciplines. The university is well known for its medical school, which dates back to the late fifteenth century. Galileo University (http://www.galileo.edu/) is a new university created in 2000, with a focus on information technology. Based in Guatemala, Galileo is a leader in Central American education in the study of technology planning and analysis; electrical engineering; and the design, development, and application of educational technology solutions. Today, the LMS has 16,000 registered users, and actively supports 524 courses, 100 professors, and nearly 3,000 students. The University of Bergen (http://www.uib.no/info/english/) is Norway's major urban university, with two main physical campuses. The university's 17,000 students make up 10% of the population of Bergen, and its many centers and institutes are the city's most important academic institutions.

Not all universities surveyed use dotLRN as an enterprise solution. Some use it in combination with new ICTs to extend the students' face-to-face experience. For this reason, the number of users tends to be comparatively lower. Universidad Nacional de Ingeniería, Nicaragua (http://www.uni.edu.ni/) uses dotLRN to support the face-to-face learning experiences of 1,000 students. The University of Sydney is a research-intensive, campus-based university in Australia. DotLRN in this university is used to support the face-to-face learning experience of around 500 users. Universidad Carlos III de Madrid (http://www.uc3m.es/) is a modern university, created in 1989, in the outskirts of Spain's capital. It is organised into three centers: the social sciences and law faculty; the humanities, documentation, and communication faculty; and the school of engineering. Approximately 300 students use dotLRN to support their studies.

In order to investigate readiness for the quality assurance of dotLRN in the universities surveyed, we used open-ended questions concerning key issues related to the "necessary but insufficient" indicators for QA.

The open-ended questionnaire

The size of the project and the geographically dispersed nature of the participants determined that the most efficient methodology for data collection was an open-ended questionnaire. The questionnaire comprised six sections: leadership, policy, problem management, staff development, user support, and evaluation. These sections made the most sense to participants in terms of key areas of activity related to an implementation of dotLRN while considering high-level management, educational, and technological issues.

The first question in each section was an open-ended question, designed to allow as much variation in responses as possible. The following questions in each of the section targeted more specific issues that the researchers considered noteworthy.

Administration and analysis

We established discussions with all potential university members of the dotLRN Consortium. Recruitment took place through these discussions, and 80% of the universities contacted agreed to complete the questionnaire in sufficient detail for analysis. Questionnaires were emailed to respondents, who completed and return them to the researchers within a four-week period. Answers were assessed for their level of detail and completeness. Table 2 below summarizes the answers provided by the respondents.

Table 3. Open-ended questionnaire items

Questionnaire: Assuring the quality of dotLRN use in campus-based universities		
1. Leadership		**Indicator number**
1.1	Who is the most senior sponsor of learning management systems used to support student learning in your university? To whom do they report?	1
Policy		
1.2	What sort of university policies exist that influence the implementation or administration of “dotLRN”? What are the policies for?	2
1.3	Does university policy require staff to cyclically review course websites on “dotLRN”? If so, how often? Do staff review the course websites or does someone else?	2 and 3
1.4	Does university policy require staff to observe copyright issues related to course websites on “dotLRN”? How is this monitored?	2 and 5
1.5	Does university policy shape the ongoing activities of those people administering “dotLRN”? How?	2 and 4
2. Problem management		
2.1	What sort of problem management strategies are used by the “dotLRN” administrator?	4 and 5
2.2	How often does the “dotLRN” administrator test the stability of “dotLRN”?	4 and 5
2.3	How often does the “dotLRN” administrator test the compatibility of platforms and browsers with “dotLRN”?	4 and 5
2.4	What are the backup strategies for the “dotLRN” system in case of catastrophic failure?	4 and 5
2.5	Is the live “dotLRN” server co-located with the backup server (or is it housed elsewhere)?	4 and 5
2.6	Are users of “dotLRN” required to use a university authentication service when logging on?	4 and 5
3. Staff development		
3.1	What sort of staff development activities are provided that help staff how to use “dotLRN”? Who provides them?	5 and 6
3.2	Is there any e-learning training provided for teachers using “dotLRN”? By whom?	5 and 6
3.3	Are there any examples of successful course websites available to teachers using “dotLRN” for the first time? If so, please explain.	5 and 6
3.4	Does the university provide advice about resource implications of delivery models to teachers using “dotLRN”? Is so, please elaborate.	5 and 6
3.5	Are there any allowances made in teachers’ workloads for work related to developing course websites in “dotLRN”? Is so, please add some details.	4, 5 and 6
4. User support		
4.1	What sort of user support is offered to staff and students using “dotLRN”?	4 and 5
4.2	Does the university provide a helpdesk for staff? How many hours a week?	4 and 5
4.3	Does the university provide a helpdesk for students? How many hours a week?	4
4.4	Are there any guidelines for how long it takes to reply to a staff/student query? If so, what are they?	4

4.5	Are there any guidelines for the learning design of websites on "dotLRN"? What are they?	5
5. Evaluation		
5.1	Are there any evaluation services for student learning on "dotLRN" available at the university? What are they?	3

Table 4. Summary of answers to questionnaire items by respondents from the universities in Table 3

University	Leadership & Policy					Problem management					Staff development						User support					Evaluation
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1
University A	√	x	x	x	√	√	√	√	√	x	√	√	√	x	√	√	√	√	√	√	√	x
University B	√	x	x	√	√	√	√	x	√	√	√	√	√	x	x	x	√	√	√	√	x	√
University C	x	x	x	x	x	√	x	x	√	√	√	x	x	x	x	x	√	√	√	x	x	x
University D	√	x	x	x	√	√	√	√	√	√	√	x	√	√	x	x	√	√	√	√	x	x
University E	x	√	√	x	√	√	√	√	√	√	√	√	√	√	x	x	√	√	√	x	x	x
University F	√	x	√	x	√	√	√	x	√	x	x	√	√	x	x	x	x	x	x	x	x	x
University G	√	√	√	√	√	√	√	x	√	√	√	√	x	√	√	√	√	√	√	√	x	√

Table 4 is a summary of responses made by the participating universities. It can be read in five sections: leadership and policy, problem management, staff development, user support, and evaluation. The symbol "x" indicates (based on the answers in the questionnaire) that the university does not appear to have a minimum set of processes and systems in place to generally claim sufficient resources devoted to the area investigated. The symbol "√" indicates that it does. The greater the number of x's in a section, the greater the need of attention to the area. The following identifies the criteria by which the researchers assessed the responses by the universities:

Leadership: For enterprise-level users of dotLRN, universities were assessed as having a high-level sponsor if the nominated person reported to the most senior academic manager in the university, for example, in Australia, the vice-chancellor, or in Europe, the Rector (1.1, 1.2). For lower-level users of dotLRN, the departments were assessed as having a high-level sponsor for dotLRN if the nominated person was the dean of the faculty or (the equivalent).

Policy: Universities/departments were assessed as having a policy-led approach to the implementation of dotLRN if existing policies required:

- performance indicators of quality of materials, for example, regular quality-assurance checks of websites on dotLRN (1.2, 1.5);
- cyclical reviews of websites (1.3);
- observation of copyright issues (1.4);
- performance measures for people involved, for example, helpdesk support and attendance (1.5).

Problem management: Universities/departments were assessed as having problem-management strategies for the management and review of dotLRN (2.1) if the following occurred:

- regular testing of stability of the platform (2.2)
- regular compatibility checks of dotLRN with browsers (2.3)
- existing backup strategies in case of catastrophic failure (2.4, 2.5)
- user-interoperability standards (2.6)

Staff development: Universities/departments were assessed as having staff development for dotLRN use (3.1) if the following were present:

- training for teacher-users (3.1, 3.2)
- examples of course websites (3.3)
- advice about resource allocation (3.4)
- acknowledgement of the effort involved in using dotLRN (3.5)

User support: Universities/departments were assessed as having user support for dotLRN (4.1) if the following existed:

- helpdesk for staff and students (4.2, 4.3)
- guidelines for responding to users (4.4)
- guidelines for the learning design of course websites (4.5)

Evaluation: Universities/departments were assessed as having sufficient evaluation services (5.1) if the following were present:

- a service designed to evaluate the holistic student-learning experience
- as part of that service, evaluation items related specifically to the use of dotLRN as a way of supporting student learning

The points under each section described above can be read as emergent minimum standards for the management and evaluation of dotLRN supporting student learning in blended contexts. The authors are not suggesting that these are the only minimum standards required for the successful ongoing management of dotLRN, but that they start to describe a space of activity that combines related management, educational, and technology issues related to the LMS.

Discussion

This study investigated the experience of seven universities that use dotLRN as a student learning management system in relation to a minimum set of indicators for its quality assurance and improvement. The nexus between the quality-assurance issues and the open-ended questionnaire used to collect information from respondents is identified in column 3 in Table 1. This section discusses the issues in terms of the indicators necessary but not sufficient for the quality assurance of student learning enabled by dotLRN when it is used to complement face-to-face experiences of learning.

Limitations

Before discussing the results in terms of the indicators, some limitations of the study should be noted. Firstly, the population sample included only seven universities. To develop more robust results, a second study, with a larger sample, should follow this one. Secondly, as with all research into widespread activity, a balance needs to be struck between the depth and breadth of the aspects of the phenomena being considered. In future administrations of the survey, accompanying interviews would enable a deeper analysis of the issues.

The study has indicated some areas of investigation that would increase the breadth of questions used in the survey. On reflection of the results in combination with some of the benchmarking literature (Bacsish, 2005a; Marshall, 2005), we believe an integration of strategic planning and funding questions would add to the issues raised by the course development and teaching process. In addition, it may prove to be more revealing if two surveys were used in the future: one for university-wide installations and one for local installations, to improve clarity of the issues at each level.

The limitations notwithstanding, the results provide some interesting outcomes for those interested in emerging developing standards for the management and evaluation of student learning supported by learning management systems.

Leadership

Based on universities' responses by to the questionnaire, it seemed that if a sponsor of sufficiently high level was not interested in the use of an LMS as a way of supporting student learning, then there was unlikely to be sufficient sustained commitment to the maintenance and improvement of an LMS to support student learning. For small-scale installations at the department or discipline level, the ongoing sponsorship of the dean seemed necessary. For university-wide enterprise installations, an executive reporting to the most senior academic manager was considered necessary. The first section of Table 4 suggests that most universities had someone in a position to sponsor dotLRN as a solution for managing student learning.

Policy

Table 4 shows that in the five sections of the questionnaire, the area of policy is the most undeveloped section across the institutions. In one sense, the existence of a senior sponsor, but the absence of a policy-led approach, suggests a lack of engagement of a structured approach to the management and ongoing evaluation of the LMS. It seems to the researchers that without policies helping to shape LMS-supported activities, it would be difficult to set standards for quality assurance for teachers and students across faculties.

Evaluation services

The last section of Table 4 suggests that most universities do not have evaluation services for learning supported by dotLRN, and the majority of universities do not require staff to cyclically review course websites on dotLRN (item 1.3).

Services that help teachers to holistically evaluate the student learning experience and how ICTs are used to support the experience are important to quality assurance for blended learning experiences. There is substantial research into the evaluation of student learning experiences (Biggs, 2003; Prosser & Trigwell, 1999; Ramsden, 2002), and somewhat less on blended learning experiences (for example, Ellis & Calvo, 2006; Ellis, Goodyear, Prosser, & O'Hara, 2006). Fundamentals for this area include validated student-focused surveys that consider the quality of the students' learning experience. When ICTs such as those found in dotLRN are involved, the evaluation system needs to incorporate items that evaluate the student experience of LMSs. A key issue to keep in mind is the part whole relationship between the LMS-supported learning and the whole learning experience, that is, one that includes the face-to-face experiences.

Support for teaching and learning with ICTs

Table 3 suggests that most universities have an awareness of problem management issues and strategies necessary for implementing the LMS. Most seem to engage in systematic tests of the platform's robustness and interoperability with other systems necessary for supporting teaching and learning. In comparison, there is less awareness of more people-orientated support, such as staff development and user support. In terms of supporting people, Table 4 suggests there is a greater awareness of user support issues than of staff development issues. In the context of the questionnaire, user support issues include helpdesk support, a standard response time to queries from the helpdesk, and guidelines for the learning design of course websites. Staff development issues include training for teacher-users, sample course websites for use as guides, advice about resource allocation, and acknowledgement of workload issues associated with the use of dotLRN. The responses from the universities suggest that some would have difficulty maintaining the quality of learning supported by the LMS without a more holistic consideration of these types of staff development issues.

Support for planning, design and development with ICTs

Some of the responses to issues summarized in Table 4 are particularly relevant for individual staff planning, designing, and developing resources for student learning through an LMS. The issues include copyright guidance (1.4), examples of successful course website design (3.3), and guidance for learning how to design course websites (4.5). In the majority of universities surveyed, these types of resources are not provided. Furthermore, issues related to the resource allocation necessary for a use of dotLRN (3.4), including workload implications (3.5), seems to be a comparatively unsupported area of activity for most universities.

The decision to develop or redevelop a course with ICTs

In one sense, it is possible to consider almost all of the responses to the questionnaire as related to the decision-making of staff when considering extending the face-to-face learning experiences of students with a learning management system such as dotLRN. Given the work and risks involved, most teachers would understandably be loath to invest time and effort into using dotLRN if they were not assured that problems would be resolved, training was available, successful examples and design advice were accessible, workload was taken into account, and so on. It is only through a combination of all of these types of issues that quality-assured approaches to developing student experiences of learning with ICTs such as those found in dotLRN could be implemented.

Conclusion

While the issues discussed under each of the indicators have arisen through a combined experience of managing dotLRN, they appear sufficiently abstract to offer insight into similar issues for other LMSs. Before such claims are made forcefully, further research into the quality assurance of student learning supported by LMSs and their constituent ICTs will be necessary. However, universities wishing to benefit from the experience of the universities included in this study would do well to emphasise issues of leadership, staff development, and evaluation when setting up their quality-assurance systems for blended learning supported by learning management systems.

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Predictors for Student Success in an Online Course

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ABSTRACT

This study analyzed the factors that affect student success in an online computer programming course. The study had two with two main objectives. The first was to examine relationships among selected variables (gender, age, educational level, locus of control, and learning style), motivational beliefs (intrinsic goal orientation, extrinsic goal orientation, control beliefs, task value, self-efficacy, and test anxiety), self-regulated learning components (cognitive strategy use, self-regulation), and student success in the online course. The second objective was to examine course instructors' views about the factors that contribute to the students' success in the online course. The study sample consisted of two course instructors and 80 voluntary participants who partook in this online course in 2005–2006. Both quantitative and qualitative methods were used to collect relevant data in this study. Four online questionnaires (Demographic Survey, Internal-External Locus of Control Scale, Learning Style Inventory, and Motivated Strategies for Learning Questionnaire) were used to gather data on quantitative variables, and semi-structured interviews were conducted to gather data on instructors' views. The statistical results indicated that the effect of the self-regulation variables on students' success was statistically significant, and the interview results indicated that successful students generally used self-regulated learning strategies in the online course.

Keywords

Online student characteristics, Motivational beliefs, Self-regulated learning components, Online student success

Introduction

Throughout the past decade, advances in information technology have affected various areas, such as communication, the nature of work, structure of organizations, daily life, and education. In particular, emerging technologies such as the World Wide Web and online communication tools have changed the face of education. These technologies create an anywhere-and-anytime learning environment that allows educators to deliver a course asynchronously, synchronously, or through a combination of the two. Also, these benefits provide easier and more convenient access for many students who are unable to attend traditional classes. With the help of these technologies, higher education institutions can begin to offer a number of distance-education opportunities to meet the needs of increasingly high numbers of these nontraditional students (Khan, 1997; Kearsley, 2000).

As distance education, especially online education, continues to expand, the need for determining and maintaining quality in the process of designing, developing, and delivering online education is becoming an important issue. It was reported that several online distance-education courses failed to meet quality standards set by researchers and institutions (Garrett, 2004; Oliver, 2005). A broad range of factors (i.e., institution, technology, instructor, student, support system, course structure, and instructional design) that can influence the quality of the educational experience in online education have been mentioned in the literature (CHEA, 2002; Fresen, 2005; IHEP, 2000; Meyer, 2002). In other words, some of previous literature identified student characteristics as one of the important considerations for the quality of online education. In addition, a general consensus among distance-education researchers in the literature is that factors that affect students' success in distance-education courses need to be identified (Biner et al., 1996; Dille & Mezak, 1991; Stone, 1992). Although numerous studies on the qualities of distance learners have been conducted, the factors that contribute to success in online learning have not been adequately described (Phipps & Merisotis, 1999). Some of the essential characteristics that affect student success as a distance learner (i.e., gender, age, educational level, locus of control, learning style, motivational beliefs, and self-regulated learning components) have been investigated in the literature. Consequently, in order to obtain evidence to increase the quality of online education, the combination of all these learner characteristics was examined to see their effects on student success in an online environment.

One of the learner characteristics that has often been the focus of research in distance education is gender. When reviewing gender-related studies, researchers have found that the effects of this variable are inconclusive with regard to student success in distance education. On the other hand, there are some differences in using online learning between male and female students in the literature. Arbaurgh (2000) mentions that males see online learning as a medium to provide education to many people more quickly and at a smaller cost. Males communicate via this medium in a competitive manner and also try to improve their own status in relation to their peers. However, females view Internet-based communication as a medium to develop higher collaboration in online learning. They are more supportive of networks to increase learning and communication for the group. As a summary, some studies reported differences between genders (i.e., Barrett & Lally, 1999; Taplin & Jegede, 2001), while others did not (i.e., Dille & Mezack, 1991; Lim, 2001).

Age is seen as another student characteristic in research studies, since distance education is viewed as very suitable to adults. The convenience, flexibility, and self-pacing of distance-education courses or programs are especially beneficial to them. Distance education allows adults to continue their education without having to disrupt their employment or family obligations (Moore & Kearsley, 1996). Dille and Mezack (1991) found that the average age of successful students in their study was 28 as opposed to an average age of 25 for non-successful students. On the other hand, Biner et al. (1996) indicated that the age of the learners was unrelated to satisfaction in their live, interactive telecourses. According to these studies, there are conflicting findings in regard to relations between age and dependent variables, such as success and satisfaction, in the literature.

Moreover, students enrolled in distance-education courses usually have a higher education level (i.e., senior, graduate student, etc.). Yukselturk (2005) reports that over 60% of students who attended an online program in his study had a bachelor's degree. Although Moore and Kearsley (1996) emphasize the importance of educational background in predicting the success factor in distance education, education level or academic standing has not been shown much in the literature to predict student success in a distance-education environment. For example, Lim (2001) report that academic standing does not affect student perceptions of web-based instruction. Also, Miller and Pilcher (2000) state that there is no significant difference in student achievement with regard to academic standing between on-campus and off-campus courses.

Researchers also agree that there is a relationship between the locus of control and student success. According to Rotter (1966), there are two types of locus of control: internal and external. Individuals who have an internal locus of control will take responsibility for their failures and congratulate themselves on their successes. Individuals who have an external locus of control tend to see their failures and successes as a result of chance, luck, or intervention by others. Research generally shows that, in the distance education environment, students with an internal locus of control are more likely to be successful than students with an external locus of control (Dille & Mezak, 1991; Parker, 1999; Stone, 1992). However, Sterbin and Rakow (1996) cite a few studies that found no relationship between the locus of control and success.

Many researchers have also included learning style as a part of the design of their studies. Kolb (1984) simply defines learning style as a preferred individual orientation toward learning. Learning style consists of a distinctive and observable behavior that provides clues about each individual. Knowing their learning style helps learners to improve their power of learning (Askar & Akkoyunlu, 1993). In the literature, there are more than 30 commercially published instruments used by researchers and educators to assess the different dimensions of learning style. One of the most common (which is also similar to what was used in this study) is Kolb's Learning Style Inventory (LSI), which categorizes learner types as Converger, Accommodator, Diverger, and Assimilator (Kolb, 1985). Although considerable research has been conducted regarding the relationship between students' learning style and success, the conclusions drawn from these studies conflict again. For example, Loomis (2000) and Dunn (2000) state that learning styles do affect student success; however, some researchers found that there is no statistically significant relationship between learning style and success (i.e., Shih & Gamon, 2001; Wang et al., 2001).

One of the most important components of learning in any educational environment is motivation. It is considered to be one of the best determining factors of student success. In the literature, the discussion of motivational beliefs includes several different constructs that have been generated by different theoretical models (e.g., attribution theory, goal theory, and intrinsic motivation theory). In this research, the theoretical framework for conceptualizing student motivation is an adaptation of the general expectancy-value model of motivation (Pintrich, 1990). The model proposes that there are three motivational components. These three components concern students' motivational beliefs about their reasons for choosing to do a task (value components that include goal orientations and task value), their beliefs about their capability to perform a task (expectancy components that include self-efficacy and control beliefs) and the affective construct of test anxiety. There are many studies related to each motivation variable and students' perception, attitude, and dropout as well as success rate. For example, some predictor components of motivational beliefs are higher levels of intrinsic and extrinsic goal value (Pintrich & Garcia, 1991; Pintrich et al., 1991), self-efficacy (Bandura, 1997; Pintrich & DeGroot, 1990, Zimmerman & Martinez-Pons, 1990), control beliefs (Pintrich et al., 1991; Pintrich & Schunk, 1996), and task value (Pintrich et al., 1991). As with traditional education, students' motivation to learn is a critical factor for them to be successful in online education (Keller, 1999; Sankaran & Bui, 2001; Song, 2000).

Research on self-regulated learning has increased exponentially in recent years. It is important for all students, as well as educators, since the primary goal of education, especially distance education, is to develop independent and self-regulated thinkers and learners. Schunk and Zimmerman (1998) state that self-regulated learning refers to the process whereby learners systematically direct their thoughts, feelings, and actions toward the attainment of their goals. In this study, following the work of Pintrich and DeGroot (1990), self-regulated learning conjoins three major constructs: (a) students' metacognitive strategies for planning, monitoring, and regulating their cognition, (b) students' management and control of their effort on classroom academic tasks, (c) cognitive strategies that students use to learn, remember, and understand the material. Research conducted on self-regulated learning shows a strong relationship between students' academic success and the use of self-regulated learning strategies (Pintrich & Garcia, 1991; Schunk & Zimmerman, 1998; Zimmerman, 2002; Zimmerman & Martinez-Pons, 1990). Similarly, the relationship between self-regulated learning strategies and success is also stated widely in the distance education literature (i.e., Azevedo et al., 2004; King, Harner, & Brown, 2000; Whipp & Chiarelli, 2004).

To summarize, the concern for student success in distance education continues to be a focus of research, even though the study results relating to student success are sometimes conflicting. This study analyzed the factors that affect online student success with regard to the two main goals. The first purpose was to investigate how online student success can be explained in terms of selected variables (i.e., gender, age, educational level, locus of control, learning style), motivational beliefs (intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, and test-anxiety), and self-regulated learning components (cognitive strategy use and self-regulation). The second goal was to thoroughly examine the instructors' views about online student success in the online course. By examining issues such as the qualities of online students, not only will this study fill a void that currently exists in the research, but it will also be useful in identifying characteristics of successful and high-risk students in online education. This information might allow institutions of higher education to implement procedures in order to design high-quality online learning environments through early intervention.

Research Questions

The following two major research questions guided this study:

- What is the extent to which selected variables (gender, age, educational level, locus of control, learning style), motivational beliefs (intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, and test anxiety), and self-regulated learning components (cognitive strategy use and self-regulation) account for student success in the online course (Data Structure and Algorithms with C)?
- What are the instructors' views about the factors that affect student success in the online course (Data Structure and Algorithms with C)?

In order to examine the first research question, the following hypothesis was stated:

- The thirteen variables together (gender, age, educational level, locus of control, learning style, intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, test anxiety, cognitive strategy use, and self-regulation) do not explain a significant amount of variance in students' success in the online course (Data Structure and Algorithms with C).

Method

This study was a combination of quantitative and qualitative research methods. The careful and purposeful combinations of different methods in social and behavioral research strengthen and deepen the analysis, and decrease the weaknesses of the study (Johnson & Turner, 2003). The quantitative part of this study was based on correlational research design. Fraenkel & Wallen (2000) stated that correlational research designs are used for two major purposes: to help explain important human behaviors or to explore relationships between variables, and to predict likely outcomes or the score on one variable if the score on the other variable is known. Considering the second purpose of the study, the qualitative paradigm was the appropriate choice. Qualitative research is descriptive and inductive, focusing on uncovering meaning from the perspective of participants (Bogdan & Biklen, 1998; Merriam 1998).

Description of the Online Certificate Program and the Online Programming Course

The Online Information Technologies Certificate Program (ITCP) is one of the first Internet-based education projects at the Middle East Technical University in Ankara, Turkey. Offered through the cooperation of the Computer Engineering Department and Continuing Education Center at Middle East Technical University, the program is based on synchronous and asynchronous communication methods over the Internet. The online certificate program was started in May 1998 and is still active.

This online certificate program provides online lecture notes, learning activities, and visual aids to course participants. One instructor and one assistant deal with each course. Also, each course has an email address, discussion list, and chat sessions to provide interaction between both instructors and students, and students and students. At the end of each semester, there are face-to-face sessions for each course. Data Structure and Algorithms with C is one of the programming courses in this online program. Students take this course in the second semester of the program. The main aim of this course is to teach basic data-structure and algorithm concepts to use in preparing different programs. The aim of providing these basic concepts is not only to enable students to use them in solving problems during the course, but also to be able to teach students how to use the concepts to find solutions to any programming problems they encounter. The course content consists of basic C programming strategies (e.g., pointers, data structures, lists, trees, searching, sorting, and algorithms). This second-semester programming course was selected to decrease some effects on the results of this study, such as students' lack of familiarity with online learning, environment, communication tools, and computer-programming concepts.

Subjects of the study

The study included 80 volunteer students (October 2004–June 2005) who attended the online computer-programming course at Middle East Technical University in Ankara, Turkey. All students were computer literate and had an intermediate level of English. Table 1 presents the demographic characteristics of the students. The number of male students ($N = 56$) was greater than the number of female students ($N = 24$), and the majority of the students' were between 19 and 29 years of age. In addition, the majority of the students had an assimilator learning style and a university degree.

Table 1: The characteristics of the students

	N	***P***
Gender		
Female	24	30
Male	56	70
Age		
19–24	25	31
25–29	35	44
30–34	12	15
35–39	5	6
40 and above	3	4
Education Levels		
University graduates	45	56
Undergraduate students	35	44
Learning Style		
Assimilator	52	65
Converger	13	17
Diverger	13	17
Accommodator	1	1

N: Number of students who attend the study, *P*: Percentage of students who attend the study

Instrumentation

To collect relevant data in this study, both quantitative and qualitative methods were used. The following instruments helped us collect quantitative data: Demographic Survey, Internal-External Locus of Control Scale, Learning Style Inventory, and Motivated Strategies for Learning Questionnaire.

The Demographic Survey was used to gather students' demographic information (i.e., age, gender, education level). The Internal-External Locus of Control Scale (IELOC) was used to measure students' locus of control orientation. This scale, originally developed by Rotter (1966), is a 29-item, forced-choice, self-report scale with a scoring range from 0 (internality) to 29 (externality), excluding six buffer items. The scale was translated into Turkish and standardized on a Turkish sample by Dag (1991) (N = 532). He found the Cronbach alpha coefficient as 0.71 and test-retest reliability as 0.83.

The Learning Style Inventory (LSI) was used to classify students' learning styles. This inventory was originally developed by Kolb (1985) and translated into Turkish by Askar and Akkoyunlu (1993). According to them, the reliability coefficients for the adapted inventory were calculated separately for four basic learning-style types and various combinations of them, and found to be between 0.73 and 0.88 (N = 268).

The Motivated Strategies for Learning Questionnaire (MSLQ) was used to collect data related to motivational beliefs and self-regulated learning components. It is an adapted version of the relevant sections from the MSLQ developed by Pintrich, Smith, Garcia, & McKeachies (1991). It was translated into Turkish, and the pilot study was administrated to students enrolled in the Department of Foreign Languages Education at METU, Turkey (Hendricks, Ekici, & Bulut, 2000). Also, it was used in the study of investigating mathematics achievement and self-regulated learning in the city of Denizli, Turkey, with 752 ninth-grade students. In this study, some items of the scale were lightly adjusted to ensure applicability to all students (Ozturk, 2003). The reliability coefficients for the last version of the adapted questionnaire were calculated separately for eight sub-scales and various combinations, and found to be between 0.53 and 0.89.

In addition to these questionnaires, semi-structured interviews were conducted to elicit additional information regarding student success in this online course. Interview questions were developed around the central themes of the questionnaires used in this study, and consisted of ten questions. The interview questions were examined by two experts in the field of instructional technology at the university. Some of the major interview questions were as follows:

- What are the online students' characteristics?
- What are the successful and unsuccessful students' characteristics in the online course?
- What are the major points that students like in the online course?
- What are the major points that give students difficulty in the online course?
- How could an effective online course be designed?

Data Collection and Analysis

Students who registered in the online Information Technologies Certificate Program were selected to participate in this study. During the face-to-face meetings at the beginning of program, students were informed that their participation was voluntary and that they had the right not to participate and the right not to answer all questions. Then, three instruments (Demographic Survey, Internal-External Locus of Control Scale, and Learning Style Inventory) were distributed by the researchers to the students to collect relevant data for this study. Also, the last instrument (Motivated Strategies for Learning Questionnaire) was distributed by the researchers to the students at the end of the course on the university campus. The structure of the online certificate program and the course given in this program was not changed, and researchers did not influence the students or the course instructors during the study.

With the help of these instruments, thirteen independent variables, three categorical (gender, educational level, and learning style) and ten continuous (age, locus of control, intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, test-anxiety, cognitive strategy use, and self-regulation) were gathered. The dependent variable, students' success scores, was gathered from scores on three assignments given in the course and a traditional paper-based final examination at the end of the course. Correlation and regression tests were used to analyze these quantitative data. Descriptive statistics, such as, mean and standard deviations of subjects, were calculated for the scale scores. Dummy coding was applied for the learning-style variable, and the accomodator learning style was not included in the analysis since only one student had it.

In addition to quantitative data, semi-structured interviews were conducted with course instructors (one instructor and one assistant) of the selected course. Bogdan and Biklen (1998) stated that researchers are confident that they can obtain comparable data across subjects through semi-structured interviews. The interviews were conducted by the researchers and took about 20–30 minutes. Before each interview, the instructors were informed of the purpose of the interview. Instructors have over five years of experience in teaching the online programming course in this program. The data analysis was continuous and iterative throughout data collection and report writing. This analysis process went through in iterative cycles of examining the data, exploring similarities and differences among the participants, and searching for confirming and disconfirming evidence that would be incorporated into the conclusions (Merriam, 1998).

Results

Descriptive Statistics

Table 2 shows the descriptive statistics (range, minimum, maximum, mean, and standard deviation) of variables such as locus of control (Lcontrol), intrinsic goal orientation (Intr), extrinsic goal orientation (Extr), task value (Tskv), control beliefs (Cont), self-efficacy (Slef), test anxiety (Tanx), self-regulation (Slrg), cognitive strategy use (Cstra), and student success (Success). Slrg was constructed from metacognitive self-regulation and effort regulation, while Cstra provides a measure of the use of rehearsal, elaboration, organization, and critical-thinking strategies. This table shows the descriptive statistics of MSLQ subscale scores, converted into a 7-point Likert-type scale, similar to the original scale), the locus of control (ranging from 0 to 23), and student success (ranging from 0 to 100).

Table 2: Descriptive statistics of MSLQ subscale scores, locus of control, and success

Predictors	***N***	**Range**	**Min**	**Max**	**Mean**	***SD***
Lcontrol	80	15.00	2.00	17.00	8.76	3.71
Intr	80	6.00	1.00	7.00	5.12	1.21
Extr	80	5.00	2.00	7.00	4.34	1.09
Tskv	80	5.50	1.50	7.00	5.44	1.03
Cont	80	4.00	3.00	7.00	5.46	0.99
Slef	80	4.38	2.63	7.00	4.74	1.10
Tanx	80	5.60	1.00	6.60	3.44	1.25
Slrg	80	4.13	2.25	6.38	4.50	0.95
Cstra	80	4.47	2.05	6.53	4.16	0.94
Success	80	95.64	4.36	100	39.82	28.20

Table 2 demonstrates that students mainly have an internal locus of control (mean = 8.76). Furthermore, motivational subscales range from 3.44 to 5.46, which means that students tend to reflect an "agree" perspective toward their motivational beliefs about programming especially with regard to intrinsic goal orientation, task value, and control beliefs. They have an "undecided" perspective about extrinsic goal orientation, and a "disagree" perspective about test anxiety. In addition, they tend to reflect an "undecided" perspective on self-regulated learning components in programming, with mean scores ranging from 4.16 to 4.50.

Results of Testing the Hypothesis

The problem of this study was examined by means of its associated hypothesis. The hypothesis was in the null form and tested at a significance level of 0.05. The interrelationships among variables before testing hypotheses were examined due to the concern about the issue multicollinearity. Therefore, Pearson Product-Moment correlations were conducted to examine the interrelationships among measures. The correlation matrices were presented in Table 3. Table 3 shows that predictor variables did not have high correlations among themselves; therefore, we deduced that multicollinearity was not a problem in this study.

Table 3: Pearson Product-Moment correlations among measures for all subjects of the study

Variables	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1. Gender	-0.11	0.03	0.11	-0.63	-0.63	-0.16	0.16	0.17	0.17	0.05	0.05	0.01	0.16	0.20	**0.02**
2. Age		-0.5*	0.10	0.04	-0.18	-0.05	0.20	-0.3	0.17	0.09	0.22*	-0.04	0.19	0.06	**0.13**
3. Edulevel			-0.01	-0.04	0.09	0.13	-0.29*	0.06	-0.20	0.01	-0.23*	0.11	-0.26*	-0.13	**-0.28***
4. Assimilator				-0.61*	-0.61*	-0.08	0.02	-0.11	0.09	0.08	-0.04	-0.15	0.07	-0.03	**-0.05**
5. Converger					-0.20	-0.09	0.03	-0.04	-0.05	0.02	0.12	0.11	0.14	0.13	**0.15**
6. Diverger						0.14	-0.09	0.21	-0.07	-.012	-0.06	0.02	-0.24*	-0.08	**-0.08**
7. Lcontrol							-0.32*	-0.16	-0.31*	-0.27*	-0.37*	-0.09	-0.40*	-0.38*	**-0.24***
8. Intr								0.2	0.79*	0.38*	0.69*	-0.06	0.07*	0.65*	**0.36***
9. Extr									0.25*	0.26*	0.25*	0.26*	0.21	0.46*	**0.06**
10. Tskv										0.50*	0.64*	-0.02	0.60*	0.65*	**0.28***
11.Cont											0.55*	0.07	0.26*	0.27*	**0.18**
12.Slef												-0.17	0.64*	0.59*	**0.39***
13.Tanx													-0.06	0.20	**0.0**

14.Slrg	0.76*	**0.39***
15.Cstra		**0.24***
16.Success		**1**

As Table 4 indicates, only one variable (self-regulation) explained a significant amount of variance in students' success, $R^2 = 0.164$, adjusted $R^2 = 0.153$, $F(1,74) = 14.53$, $p = 0$. 16.4 percent of the variances are explained by this variable. The value of Standardized Coefficients is 0.4 and Standard Error is 26 for this variable.

Table 4: Linear Stepwise Regression Analysis results for one significant predictor variable on success

Regression Statistics					
Multiple *R*	0.405				
R^2	0.164				
Adjusted R^2	0.153				
Standard Error	26.18				
	df	*SS*	*MS*	*F*	*Sig F*
Regression	1	9954.74	9954.74	14.53	0.000*
Residual	74	50719.55	685.40		
Total	75	60674.31			

$*p < .05$

Gender, age, educational level, online readiness, locus of control, learning styles, intrinsic goal orientation, extrinsic goal orientation, task value, control beliefs, self-efficacy, test-anxiety, and cognitive-strategy use were excluded from the equation of predicting success because they did not have a significant contribution to variance in success ($p > .05$).

The instructors' views about online student success

Interviews with two course instructors showed similar results about student characteristics in this online course. The instructors stated that online students were different from traditional students in various ways. Traditional students had similar characteristics (i.e., similar age level, similar background knowledge), and their primary aim was to study and learn the topics covered in the courses. However, online students were older than traditional students, and they had various responsibilities (i.e., jobs and families). Also, online students were different from each other. Their age range could be from 20 to 50, based on information provided by the instructors during the interviews. Students' background or education could be from either a social or science field. Moreover, there were some differences in their motivations and aims in attending the program. For example, some online students attended this certificate program to find a job, others attended for improving their knowledge about the IT field. According to the instructors, even though online students had different characteristics, general personal characteristics, especially, gender, age, educational level, and learning style, did not directly affect their success in the online course.

The instructors described successful students based on their experiences in the online course. First, successful students were already mature enough, initially. They were aware of their responsibilities and were self-disciplined while doing their tasks. Second, successful students were active in their learning process. One of the instructors said, "students are generally successful if they follow the course notes regularly, review and study them carefully, do their assignments timely and evaluate them by themselves, ask questions when faced with problems, and attend the discussions in computer-mediated communication tools during the course." Third, successful students were eager to interact with their peers and instructors, with the help of communication tools. They learned lots of information by interacting with peers and instructors regularly during the course. In addition, instructors mentioned that students' previous experiences, their interests related to topics, and their confidence about their capabilities might have affected the students' success in the online course.

On the other hand, instructors pointed out that some students could not meet their course requirements. They did not follow the classes regularly, and they did not prepare assignments and pass the exams in the online course. According to the instructors, there might have been various reasons for being unsuccessful in the online course. They emphasized that these reasons generally resulted from the online students' "underestimating time and effort necessary for courses, lack of time management, and unexpected emergency situations in their life." Further, instructors mentioned that some students were faced with motivation problems as well. Although most of the students started this online certificate program with a high level motivation, some students could not maintain the high level throughout the entire course. In particular, the motivation level of unsuccessful students decreased during the course. Moreover, the instructors stated that some students could not adapt to these online courses.

According to one instructor, students were not familiar with this new method of taking courses. He mentioned that the teacher-centered method is a widely used method in our education system, from primary school to university. On the other hand, instructors in this online program tried to facilitate and use student-centered methods in their courses; therefore, this new learning model might have been strange for some students during the course.

Instructors expressed the major areas of the course that students liked, as well as those students found difficult. According to the instructors, students were generally highly satisfied with the course when they were able to immediately put into practice what they had learned. In other words, students generally preferred practical information, and they wanted to integrate their knowledge into their life immediately. Therefore, instructors tried to provide students with more practical information in the course notes, such as examples, exercises, and assignments. On the other hand, the major difficulty that students faced within their course was studying the course material regularly. Due to the flexibility of online learning, students could study whenever and wherever they desired. However, instructors expressed concern that some students did not study the material and perform their requirements regularly and therefore risked falling behind the other students once work accumulated. This behavior could lead to students' dropping the course before completion.

Although the popularity of online learning has been increasing dramatically in recent years, the instructors said that designing and teaching online courses properly was not an easy job for them when compared to teaching traditional classes. They stated that online education placed all major responsibilities on the students; therefore, educators tried to create a more effective learning environment by using contemporary techniques and tools. They emphasized some of the critical issues in preparing online courses. For example, online course notes consisting of rich materials (i.e., interactive examples, multimedia applications, and reference books) should be designed carefully and updated regularly. Both synchronous and asynchronous Internet-based communication tools (i.e., email, discussion groups, and chat sessions) should be integrated into the course structure to increase interaction among students and between students and instructors. Moreover, student-centered methods, which are active-learning methods, have been designed for students to create knowledge and meaning by themselves. Individual and timely feedback could be provided regularly to the students by the educators, and educators should try to guide and help students in the learning process through the incorporation of small instructional activities.

Discussion

In order to design online courses or programs to fit the needs of online students, it is necessary to investigate the characteristics of successful online learners. In other words, research is needed to discover what will help students succeed, and the results of this research should be incorporated into the preparation of high-quality online courses. Therefore, this study focused on two main goals for online student success. The first goal was the relationship between student characteristics and online student success. The second goal was to examine the results of the online course by considering feedback from the course instructors. To meet these goals we conducted analyses with data gathered from students and instructors in an online programming course in an online certificate program.

The demographic information of students and instructors' views in this study showed that the students of the online course were of different educational backgrounds and ages, and possessed different learning styles and employment characteristics. Also, many of these students had other responsibilities outside of school (e.g., family, job) in this online certificate program. Demographic data available from several large national studies of adult students showed similar personal characteristics among online students (Thompson, 1998). In the literature, the effects of these general personal characteristics (i.e., gender, age, and learning style) on student success are inconclusive. Many study results, like the results of this study, showed that these general personal characteristics did not significantly affect student success in online courses (i.e., Lim, 2001; Wang & Newlin, 2002).

Table 3 displays the correlation among the selected characteristics of students and their success in the online course. Intrinsic goal orientation, task value, self-efficacy, cognitive-strategy use, and self-regulation were significantly positively correlated with online success. Educational level and external locus of control were the only variables that were negatively correlated with success. In addition, according to the regression analyses of this study, self-regulation related to success was the only variable to enter a regression equation in the online course regression analyses. That accounted for 16.4% of the variance in students' programming success.

Zimmerman (2000) defined self-regulation as "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (p. 14). Research states that one of the best predictors of academic success appears to be self-regulation and its strategies in educational environments (Pintrich & DeGroot, 1990; Schunk & Zimmerman, 1998; Zimmerman & Martinez-Pons, 1990; Zimmerman, 2002). Also, research shows that successful students use self-regulated learning strategies in online courses (King, Harner, & Brown, 2000; Whipp & Chiarelli, 2004; Azevedo et al., 2004). These students are described as having three main characteristics (Pintrich, 1995). First, self-regulated students try to control their behavior, motivation, and thought. Second, they aim to accomplish a goal. Last, they must be in control of their learning. Zimmerman and Martinez-Pons (1990) also stated that self-regulated learners select, organize, and plan and control the form and amount of their own instruction for their academic achievement. In doing so, they create advantageous learning environments for themselves.

Instructors also described students with self-regulated learners' characteristics as successful. Successful students were mature enough to know what they wanted in an online course. Also, they were aware of their responsibilities and could control their learning through self-discipline. Interview results also showed that successful students were active in their learning process. They followed the course notes and reviewed them regularly, and did their work carefully. At the same time, interaction with peers and instructors played an important role in ensuring students' success. Similarly, Pintrich and DeGroot (1990) state that, in addition to being able to self-regulate cognitive and metacognitive strategies (i.e., planning, organizing, self-instructing, and self-evaluating), self-regulated students are able to learn from peers, and seek help and support from peers and instructors.

Even though the other variables (i.e., intrinsic goal orientation, task value, self-efficacy, and internal locus of control) were correlated with online programming success, these variables did not enter the regression equation in the online course regression analyses. This finding contradicts previous research results (Pintrich & DeGroot, 1990; Zimmerman & Martinez-Pons, 1990; Wang & Newlin, 2002). For example, research on the self-efficacy variable (belief in one's capabilities) and the intrinsic motivation variable (one's own desire to do well) has shown that these variables also significantly affect student achievement (Pintrich & DeGroot, 1990). In line with these statements, instructors in the interview mentioned those variables that might affect student success, such as students' interest in certain topics, their previous experiences, and their confidence.

Unfortunately, not all students could be successful in the online educational environment. They were unable to meet the course requirements and therefore failed the course. Interview results showed that there were several reasons that might have negatively affected success. One of them was that students perhaps underestimated the time and effort necessary to succeed in an online course. They may have thought that they could easily pass without studying hard. On the other hand, Moore and Kreasley (1996) state that distance education places the responsibility of learning on the students much more than traditional education does; therefore, students have to study more. Further, in our study, some students were unable to manage their time properly in the online course. Research shows that time planning and management training helps students to better self-regulate their use of study time, which improves students' level of achievement (Zimmerman, Greenberg, & Weinstein, 1994). Unexpected emergency situations can also negatively affect students' success. Online students have various responsibilities apart from class. They sometimes might be faced with problems related to their job, family, or health.

Interview results also showed that some students, especially unsuccessful ones, were faced with motivation and adaptation problems within the online course. Although the statistical results showed that students generally felt they were motivated about the prospect of online learning, and the interview results showed that students started the online certificate program with a high level of motivation, instructors mentioned a decrease in the students' motivational levels as the students' progressed through the course. In other words, students could not maintain their motivation during the entire course; therefore, they risked failing the course. Similarly, according to the studies conducted on motivation in distance education, motivation has a great importance in student success and continuity (Keller, 1999; Sankaran & Bui, 2001; Song, 2000). Also, Pintrich and DeGroot (1990) stated that students should not only use self-regulated learning strategies to achieve, but also they should be motivated to use these strategies to fulfill course requirements. Furthermore, some students could not easily adapt to the online program since in traditional classes they were used to passively receiving information from teachers. In contrast, the online learning environment requires students to be active and use self-study methods in order to succeed. Hill and Hannafin (1997) emphasize this problem and state that traditional education does not prepare students for the exploration and learner-centered thinking that is necessary in online learning environment, because students are largely externally managed and teacher-directed in traditional classes.

In summary, the statistical results in this study revealed that self regulation had a significant effect on student success in the online course. Similarly, interview results in this study emphasized the successful students used self-regulated learning strategies in the online course. According to these results, we can conclude that student success is highly dependent on being a self-regulated learner and using self-regulated strategies in online courses. The self-regulated learning strategies in the literature, similar to those detailed in this study, were summarized as follows: self-evaluation, organization, and transformation; goal setting and planning; seeking information, keeping records, and monitoring; environment structuring; self-consequences; rehearsing and memorizing; seeking social assistance; and reviewing records (Pintrich & DeGroot, 1990; Schunk & Zimmerman, 1998; Zimmerman, 2002; Zimmerman & Martinez-Pons, 1990).

Conclusion and Recommendations

Many institutions of higher education have made the decision to offer both courses and full degree programs online. However, it is not easy to determine and maintain quality in the process of designing, developing, and delivering these online learning opportunities for educational institutions. There are several critical success factors for quality online education (CHEA, 2002; Fresen, 2005; IHEP, 2000; Meyer, 2002). One of these factors is the student. According to Fresen (2005), Students can influence the quality of online education through the following: communication with fellow students, time management, expectations of efficiency and effectiveness, critical thinking strategies, motivation, commitment, self esteem, and improved problem-solving abilities. Moreover, Meyer (2002) mentions quality factors in distance education, and states that student learning might also depend on a number of individual qualities, such as attitude, motivation, and sufficient computer skills. In sum, the previous literature suggests that student qualities are reported to be a critical factor in the quality of online education.

There is a need in higher education to ensure that the standards set by national and international accrediting organizations are being met. One standard used by accrediting organizations to monitor quality and credibility is student learning outcome and student success (CHEA, 2002). Here, in this paper, we aimed at exploring characteristics of online students and the factors that contribute to their success. By understanding the factors that affect student success and implementing procedures to increase learning outcomes, higher education institutions can ensure the course or program quality meets credibility standards. In particular, we found self-regulation to be a significant factor affecting online student success. Based on the results of this study, the following major recommendations can be offered for online courses to design high-quality learning environments:

- Learners should be directed to be self-regulated learners (metacognitively, motivationally, behaviorally active participants), and self-regulated learning strategies could be provided to enhance students' achievement of intended learning outcomes (Zimmerman, 2002; Zimmerman & Martinez-Pons, 1990; Pintrich & DeGroot, 1990; King, Harner & Brown, 2000; Whipp & Chiarelli, 2004);
- Orientation to give information about the nature of online learning and its requirements should be provided to students to enable them to better understand and determine whether they can handle the requirements of an independent environment. Also, they should be guided to adapt to different environments and learning methods (i.e., the student-centered methods);
- Learners should be encouraged to keep their motivation at a high level through the help of instructional activities during the online course;
- Learners' performance should be monitored, and individual and timely feedback should be provided during the online course;
- Interaction, especially among students, through both synchronous and asynchronous communication tools should be encouraged, so that students can work together, share information and opinions, analyze data, and solve problems;
- Course contents should be of immediate real-life value for the students. Also, course content should consist of rich materials (i.e., interactive examples, multimedia applications, reference books) that are updated regularly to reflect the students' needs and new technologies.

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Enhancing the Quality of e-Learning in Virtual Learning Communities by Finding Quality Learning Content and Trustworthy Collaborators

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ABSTRACT

Virtual learning communities encourage members to learn and contribute knowledge. However, knowledge sharing requires mutual-trust collaboration between learners and the contribution of quality knowledge. This task cannot be accomplished by simply storing learning content in repositories. It requires a mechanism to help learners find relevant learning content as well as knowledgeable collaborators to work with. In this paper, we present a peer-to-peer based social network to enhance the quality of e-learning regarding knowledge sharing in virtual learning communities. From a technical viewpoint, we will present advanced semantic search mechanisms for finding quality content and trustworthy collaborators. From the social viewpoint, we will address how to support a trustworthy social network that encourages learners to share. Results of this research demonstrate that applying such mechanisms to knowledge sharing can improve the quality of e-learning in virtual learning communities.

Keywords

Quality of e-learning, quality content, trustworthy, knowledge sharing, virtual learning community

Introduction

The explosion in web-based technology has led to increasing volume and complexity of knowledge, which stimulates the proliferation of virtual learning communities (VLCs). VLCs are information technology-based cyberspaces in which individuals and groups of geographically dispersed learners accomplish their goals of e-learning. One of VLCs' purposes is to encourage knowledge sharing so that valuable knowledge embedded in the network can be effectively explored. Most of the learners participate in VLCs with the expectations that they can acquire and share valuable knowledge to suit their needs.

The emergence of VLCs over the past decade has stimulated research interests by academia and practitioners. Bruckman (2002) found that the learning potential of the Internet technology can come from peers and elders. Jin (2002) provided a conceptual framework for the development of a prototype system of the virtual community-based interactive learning environment. Wachter et al. (2000) pointed out that an enhanced learning environment is possible only if one goes beyond mere online course delivery and creates a community of learners and other related resource groups. Wasko and Faraj (2005) found that knowledge sharing has been a motivation for participation in virtual communities. In addition, many web-based or agent-based models and software have been proposed to support interaction, discussion, and collaboration in VLCs (Taurisson & Tchounikine, 2004; Zhang & Tanniru, 2005; Matusov, Hayes, & Pluta, 2005; Avouris, et al., 2004). Prior studies have provided evidence that demonstrates the importance of knowledge exchange in enhancing learning performance. They also have called for the attention of providing mechanisms to support knowledge sharing in VLC environments.

However, knowledge sharing in some VLCs has not lived up to expectations. Two barriers preventing efficient and effective knowledge sharing are: (1) the difficulty in finding quality knowledge, and (2) the difficulty in finding trustworthy learning collaborators to interact with.

The objective and contribution of this research is applying peer-to-peer (P2P) based social networks with trust-management mechanisms to overcome the aforementioned barriers. In order to help learners find quality content and trustworthy collaborators, we provide peer-ranking mechanisms and classify peers based on their content's quality. We have enhanced the typical keyword search with a keyword thesaurus search and a semantic search to improve the performance of content discovery. We have also enhanced conventional online group discussions by finding trustworthy collaborators who are more willing to share.

Finding relevant and quality learning content

One of the motivations for participating VLCs is knowledge sharing. Without high-quality content, a VLC cannot achieve its intended purpose of encouraging knowledge sharing. The information areas for course materials, discussion forums, newsletters, and recommended articles in a VLC's website constitute its knowledge/experience repository. Whether learners can effectively explore and exploit the knowledge within a VLC significantly influences the extent to which knowledge sharing can be achieved. High-quality content can attract learners to participate in the knowledge activities and continually add to and enrich the knowledge in the repository, which in turn, facilitates knowledge sharing.

Knowledge domain and quality control

To facilitate content resource management, we classify resources based on their knowledge domains and their quality. We utilize ACM Computing Classification System 1998 (http://www.acm.org/class/1998/) as our classification base for knowledge domains. In order to organize and provide better resource management, each peer in our P2P network needs to classify content and evaluate the quality of content based on their reputation, number of times the site is accessed per day, and the matching degree by which the content classification conforms to the knowledge domain. The quality of resource *i* in knowledge domain *j* is given as

$$QoR_{(i,j)} = REP_{(i,j)} \times TOA_i \times MD_{(i,j)}$$

where:
QoR: quality of a content resource
REP: reputation represents the rating of the resource, the higher it is, the better the reputation is.
TOA: the total number of times a resource has been accessed per day. TOA represents the degree of popularity, the higher it is, the more popular it is.

MD: the matching degree of how a content classification conforms to knowledge domain, the higher it is, the better the match.

The quality of a peer with respect to a certain knowledge domain, *j*, is the summation of the quality of resource,*i*, over the number of content resources, as given below:

$$QoP_j = \frac{\sum_{i=1}^{NoR} QoR_{(i,j)}}{NoR}$$

where
QoP: quality of a peer
NoR: the number of content resources, which represents the volume of content in a peer.

The quality of a peer with respect to all knowledge domains contained in this peer is the average of QoP_j, which is given as follows:

$$QoP = \frac{\sum_{j=1}^{NoD} QoP_j}{NoD} \quad = \quad QoP = \frac{\sum_{j=1}^{NoD}\left(\frac{\sum_{i=1}^{NoR}(REC_{(i,j)} \times TOA_i \times MD_{(i,j)})}{NoR}\right)}{NoD}$$

where

NoD: number of knowledge domains, which represents the scope of this peer.

P2P-based content search

Based on the content classifications and their quality control, we now present our P2P environment and illustrate how to use it to find more relevant quality content. We have constructed a P2P environment, as shown in Figure 1. Each peer in our P2P environment consists of two modules: Resource Module and Search Module. The Resource Module is designed to formally describe resources contained in a peer. The Search Module is responsible for generating user's search query and processing search requests received from other peers.

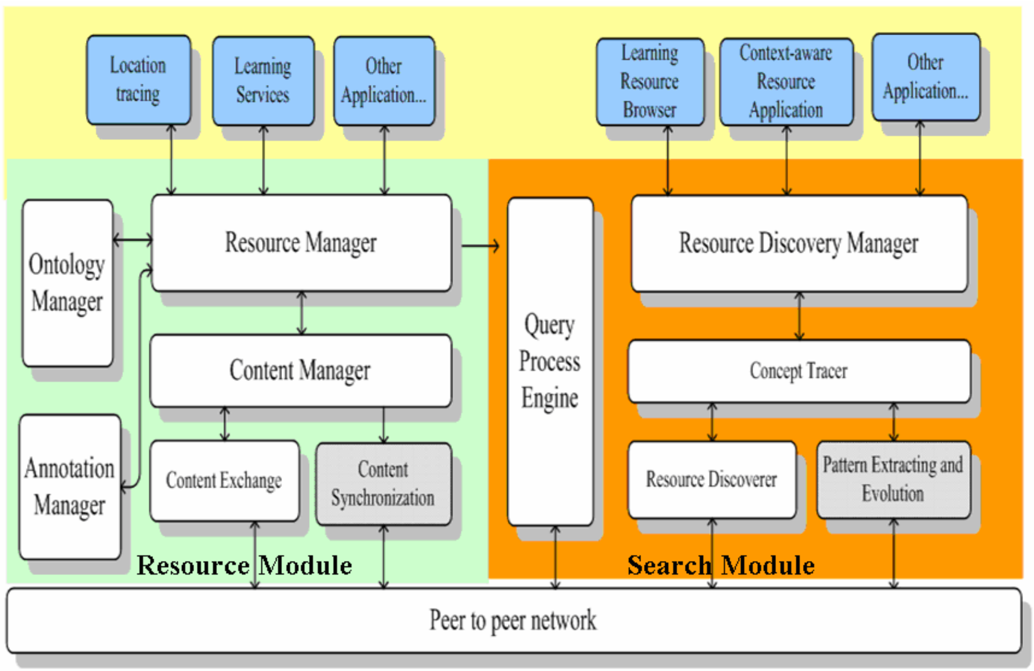

Figure 1. System architecture of peer-to-peer network

The Resource Module contains several managers to organize and manage the resources kept in the peer. The Resource Manager is the coordinator that handles all kinds of resources from various managers. These resources can be learning content, learning services, or other applications provided by the peer. The managers include the Content Manager (which handles the content repository), the Ontology Manager (which provides semantic metadata of contents), and the Annotation Manager (which processes annotation imposed onto the content).

The Search Module contains a Query Process Engine and a Resource Discovery Manager. The Query Process Engine is an interface designed to generate search requests. If users cannot specify their search request clearly, the Query Process Engine automatically generates one for users based on the surrounding context. The Resource Discovery Manager is designed to process search requests received from other peers by providing a concept map to guide the searching process. The concept map is derived from the keyword dictionary and keyword thesaurus terms based on users' requests; the concept map is extended or redrawn to match users' search requests.

We have enhanced and implemented P2P in our previous research (Yang, Chen, & Shao, 2004; Yang 2006). For content discovery, our P2P provides the functions of a basic keyword search, keyword thesaurus, and concept map-based search. Based on the content classifications and their quality control, the keyword thesaurus is used to extend search scope by finding more relevant keywords. In contrast, the concept map-based search is used to derive a more precise search scope by finding the most relevant keyword.

As shown in Figure 2, the basic keyword search is enhanced by a keyword thesaurus. Our P2P matches not only a single keyword but also a set of related keywords previously classified and saved in our content repository. The search results are shown in the main window along with resource's file name, type, size, state, and rating. For example, a keyword search of "New York Vacation" will generate a keyword thesaurus, providing terms such as "New York City Life," "New York Travel," and even "New York Yankee."

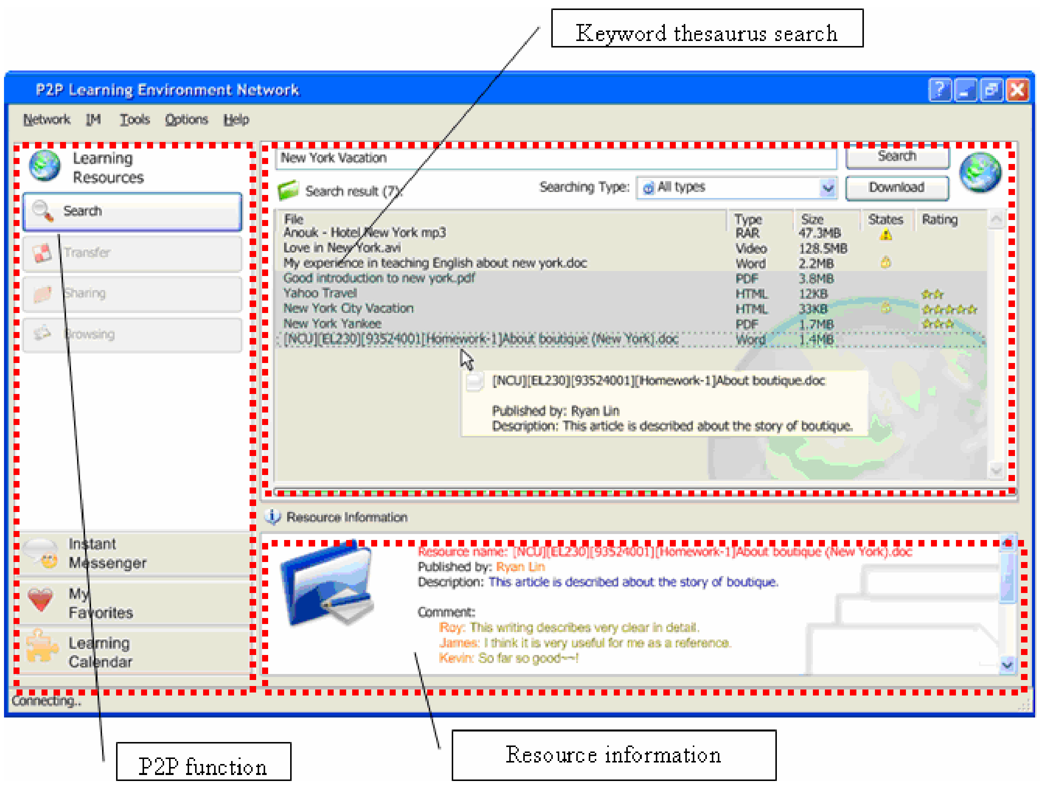

Figure 2. P2P network with keyword thesaurus search

For a semantic search, we use the concept-map approach to construct the relationship of a keyword concept and its related concept (Chau, & Yeh, 2004). For example, if a user inputs the concept "web services," the system will prompt a concept map with three nodes and two edges. One edge connects from web services to Semantic Web, and the other connects from web services to DAML-S. If the user continues to press the node"Semantic Web," the concept map will grow closer to the one shown in Figure 3. If the user then double-clicks the node "XML," the system will proceed to do the search and generate the results. In the upper left window of Figure 3 is the description of the concept. The lower left window shows the types of resources and their abstracts related to the concept, and the lower right window shows detailed information regarding the resource selected from the lower left window.

Finding trustworthy and socially related learning collaborators

Social-interaction ties are the structural links created through the social interactions among individuals in a network (Burt, 1992; Putnam, 1995; Wasko, & Faraj, 2005; Zhang, Jin, & Lin, 2005). Previous studies suggest that an individual's centrality in an electronic network of practice can be measured using the number of social ties an individual has with others in the network (Ahuja et al., 2003). Some academics addressed the importance of social interaction ties in knowledge exchange. For example, Tsai and Ghoshal (Tsai, & Ghoshal, 1998) found that social-interaction ties have positive effects on the extent of inter-unit resource exchange. Wasko and Faraj (2005) found that the centrality built up by the social-interaction ties that any individual creates in a network significantly and positively impacts the helpfulness and volume of knowledge contribution.

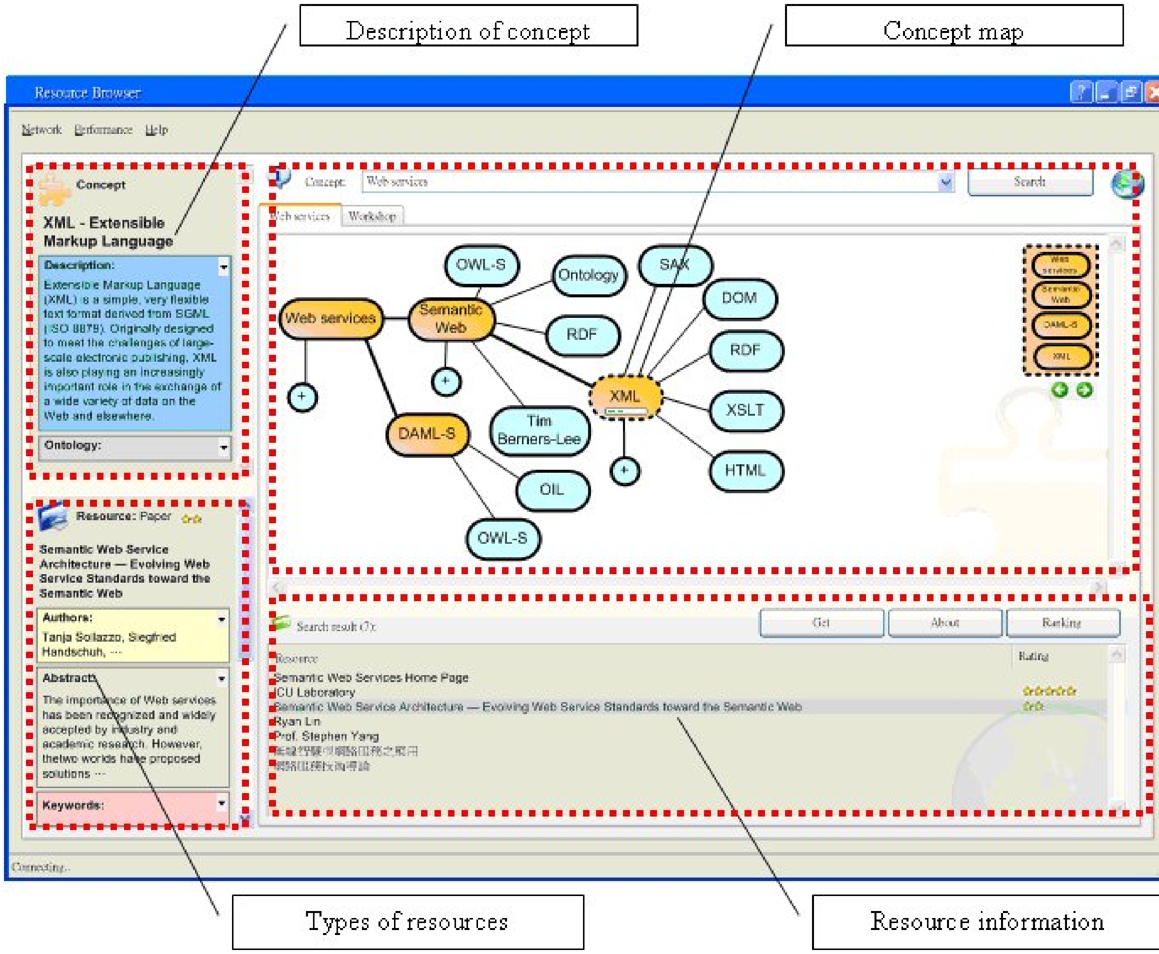

Figure 3. P2P with concept map

The Internet enables knowledge sharing in ways that were not possible before, such as through online group discussions. It also gives rise to virtual learning communities (VLCs), which enable knowledge exchange without any physical meeting among the participating members. A virtual learning community is a special kind of virtual community that aims to enhance learning performance. VLCs provide an interactive environment of mutual sharing and learning. The objective of knowledge management in VLCs is to facilitate exploitation and exploration of knowledge. Therefore, the learning process in such environments involves intensive online knowledge sharing between learning collaborators: the learners (consumers) and the contributors (producers) of knowledge.

A VLC's knowledge has both explicit and implicit components. The explicit knowledge can be easily browsed over the Internet, yet its implicit knowledge resides in the heads of the community members themselves and is shared with others through social interaction. Posting and responding to messages creates a social-interaction tie between learners. The more social interaction ties a learner has, the more easily he/she may acquire or share relevant knowledge. Therefore, social-interaction ties are positively associated with knowledge quality in a virtual learning community.

P2P-based social network support

The term social network (Upadrashta, Vassileva, & Grassmann, 2005; Wellman, 1997) is used to describe a learner's social relationship with other learners in a VLC. We implement a hierarchical P2P-based social-network support for knowledge sharing. As shown in Figure 4, a P2P knowledge network (K-network) is established to connect active learners within a pool of active peers, i.e., the learners (peers) that are online and available through the Internet. The pool can be an entire P2P network or a specific virtual community. Each peer (e.g., a ~ f) in Figure 4 represents a knowledge repository or a knowledgeable individual.

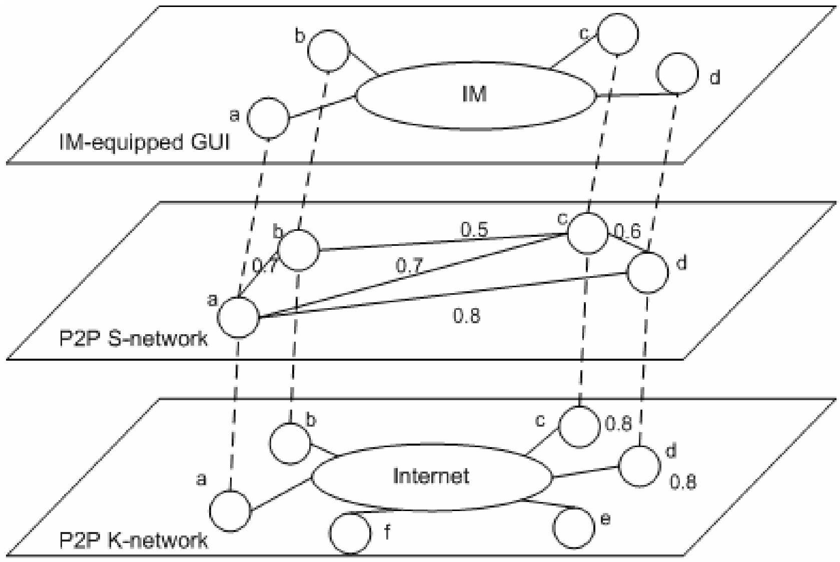

Figure 4. P2P-based social network support for knowledge sharing

If a peer in a P2P K-network, e.g., peer *a*, requests a specific piece of knowledge, the social-network support will dynamically generate a P2P S-network based upon the requester's social relationships with other peers who own the requested knowledge. As shown in Figure 4, peers that do not know about the relevant knowledge are filtered out and will not appear on the P2P S-network (e.g., peers *e* and *f*). Weighted edges in the generated S-network are called trust association (TA) to represent the levels that the peers can help the requester (peer *a*). Based on the example shown in Figure 4, peer *d* is more trustworthy than peer *c* because the TA between peers *a* and *d* is 0.8, which is greater than the TA between peers *a* and *c*, which is 0.7. Based upon the generated S-network, an IM-equipped (instant messenger) Graphical User Interface (GUI) is created to help the requester interact with other peers in real time.

The essential technique in such social-network support is how to construct a social network with trustworthy collaborators. The construction of such a social network is mainly based upon calculations of social-network association between peers in the P2P environment. Each pair of peers is associated with two kinds of association—trust association and knowledge association, which will be addressed in the following subsections.

Trustworthy social networks

The concern of trustworthiness in a social network can be classified into three levels—infrastructure, understanding, and policy. Infrastructure, the first level, focuses on keeping a trusted infrastructure. For example, the underlying software and hardware of a web-based VLC must be trustworthy. The network should guarantee that network transmission is reliable and secure.

Understanding is the second level of trustworthiness. Huhns and Buell (2002) pointed out that we are more likely to trust something if we understand it. One needs to confirm with confidence the things he/she requested. One approach is to analyze experiences and estimate the degree of trust based on one's past experiences (Singh, 2002), such as rating services, reputation mechanisms, and referral networks for exchanging experiences and reputation based on a third-party certification group (Grandison, 2000) or a peer-to-peer sharing mechanism (Yolum and Singh, 2002).

Policy, the third level of trustworthiness, is used to describe requirements of trust, security, privacy, and societal conventions to reach high-level trustworthy objectives (Huhns, 2002; Singh, 2002). In general, the policy provides many specific description - methods to enable the requesting party to define what states and situations it could accept. In other words, policy works as a set of rules to decide what behaviors and states could acquire authorizations. In this paper, we present an experience-based evaluation of learners' trustworthiness based on understanding and policy levels.

Calculation of trust association

Trust association is a measure of how two peers (learners) on the social network treat each other. It also indicates how a learner is associated with other learners directly connected to her on the social network. For a pair of learners who are socially related, as denoted by the requesting learner *i* and the requested learner *j*, the trust association between the two learners is denoted by TA(i,j). TA(i,j) indicates the level of trustworthiness of the requesting learner *i* to the requested learner *j*. TA(i,j) is used to determine whether the requested learner conforms to the requesting learner's requirements of trustworthiness. The value of TA(i,j) is denoted by a percentage. The higher the percentage of confidence, the higher the trust association. For example, if the value of TA(Chris, Albert) is 78%, which means the requesting learner Chris has 78% confidence that the requested learner Albert is trustworthy.

We utilize sampling of binomial probability to calculate the value of TA(i,j), based on a 95% confidence interval in terms of probability (Mitchell, 1997). We first define the following terms:

- S is a set of interaction instances representing samples of the requested learner's past interactions, $S = \{s_1, s_2, \dots s_n\}$.
- Tr is a set of trust evaluation values containing past experience instance, and is denoted by $Tr = \{tr_1, tr_2, \dots tr_n\}$.
- $Rating : S \rightarrow Tr\ Rating(s)$: The Rating function maps the interaction instance s to past experience instance, tr. In other words, the function associates past service instance with past experience instance, the experiences are collected by learners other than the requesting learner.
- $Accpet : Tr \rightarrow \{0,1\}$ A requirement hypothesis can be denoted as $Accpet$ function. The output of Accept function is 1 when past experience instance is accepted by the requesting learner, otherwise is 0.

$$\text{Accpet}(\text{tr}) \equiv \begin{cases} 1 & \text{Accept} \\ 0 & \text{otherwise} \end{cases}$$

Based on the usage of LargeSample of Hypothesis for a Binomial Proportion to evaluate the simple error and true error of a hypothesis addressed in (Mitchell, 1997; Mendenhall, 1999), the result of the hypothesis assesses that the sample is a Boolean value (true or false). Thus we can see that the hypothesis assesses the sample as a Bernoulli trial, and the distribution of the Bernoulli trial is a binomial distribution. The binomial distribution approximates the normal distribution when there are large enough samples. Simple error is the correct rate in samples, and true error is the correct rate in population. We will get a confidence interval according to the simple error. The area of confidence interval represents a probability in which true error falls. In normal distribution, the true error is when 95% of the resultsfall within the range of $mean \pm 1.96 \times SD$ (Standard Deviation) in compliance with the experience rule. In other words, we can utilize the confidence interval to evaluate lowest true error of the evaluating hypotheses.

Let $Accpet$ function be the hypothesis, and then we can evaluate the possible true error of the hypothesis based on the past instances S according to the Evaluating Hypotheses Theory (Mitchell, 1997). Whether the tr ($tr \in E$) is accepted by $Accpet$ is a binomial distribution which approximates the normal distribution when the number of samples is large enough. Thus we can utilize the normal distribution to ensure that the sample error closes with the true error. The true error occurs when 95% of probabilities fall within a confidence interval, which will be approved as a trustworthy learner in the general application.

We define the confidence symbol as the lowest bound of the true error. The trust of service conforms to the request's requirement when the confidence is higher.

$$\hat{p} = \frac{1}{n}\sum_{s \in S} Accpet(Rating(s)),\ SD = \sqrt{\frac{\hat{p} \times (1-\hat{p})}{n}},\ z_{95\%} = 1.96$$

$$Confidence \equiv \max\{\hat{p} - z_{95\%} \times SD, 0\}$$

As the number of samples increases, the standard deviation decreases relatively, and the confidence will be closer to the true error. For example, the past instances of a requested learner are denoted as S, and let $|S| = 256$. The requesting learner proposes a Requirement Hypothesis $Accpet$. If the result of the calculation is $\hat{p} = 0.6$, the confidence can be calculated from the following equation:

$$\hat{p} = \frac{1}{256} \sum_{s \in S} Accpet\big(Rating(s)\big) = 0.6,\ z_{95\%} = 1.96$$

$$Confidence = \hat{p} - z_{95\%} \times \sqrt{\frac{\hat{p} \times (1 - \hat{p})}{256}} \cong 0.6 - 0.060012 = 0.539987$$

The calculated confidence, i.e., TA(i,j) is 53.99%, which means the requesting learner has 53.99% confidence that the requested learner can meet the trustworthy requirement based on 95% confidence interval. Hence, we can assert that the trustworthiness of the requested learner is 56.83% (53.99% over 95%) conforming to the requesting learner's requirements.

Calculation of knowledge association

Learners' knowledge association can be described by learners' domain of knowledge along with their proficiency pertaining to the corresponding domain. We use the ACM Computing Classification System to classify domain of knowledge, and use Bloom's taxonomy matrix (Benjamin, 1956; Anderson, 2001) to classify learners' proficiency in that domain. As shown in Figure 5, the Bloom taxonomy matrix consists of two dimensions, the knowledge dimension and the cognitive process dimension. Each cell in the matrix is associated with a value ranging between 0 and 1, indicating the level of proficiency. For example, given a learner with a Bloom's taxonomy matrix rating, as shown in Figure 5, indicates the learner is good at memorizing and understanding factual and procedural knowledge pertaining to the corresponding domain.

	Cognitive Process Dimensions					
Knowledge dimension	Level 1 Remember	Level 2 Understand	Level 3 Apply	Level 4 Analyze	Level 5 Evaluate	Level 6 Create
A. Factual knowledge	0.9	0.8	0.4	0.4	0	0
B. Conceptual knowledge	0.3	0.3	0.3	0.1	0	0
C. Procedural knowledge	0.6	0.5	0.3	0.2	0	0
D. Metacognitive knowledge	0	0	0	0	0	0

Figure 5. Example of the Bloom taxonomy matrix

Let a learner in a P2P K-network request for a specific piece of knowledge *k* with proficiency, denoted by a Bloom taxonomy matrix, $BT_{(k)}$. Whether a learner *i* conforms to the request of learner *i* is computed by:

$$KA_k(i) = KP_k(i) \bullet (BT_{(k)}(i))$$

where

$KA_k(i)$: The knowledge association of a learner, *i*, with respect to a certain domain of knowledge, *k*. $KA_k(i)$ is a Bloom taxonomy matrix.

$KP_k(i)$: The knowledge proficiency of a learner, *j*, with respect to a certain domain of knowledge, *k*. $KP_k(i)$ is a Bloom taxonomy matrix.

$BT_{(k)}(i)$: A learner, *i*, requesting a specific piece of knowledge, *k*, with proficiency, $BT_{(k)}$. $BT_{(k)}(i)$ is a Bloom taxonomy matrix.

The matrix notation of KA can be further serialized into a single value by the following:

$$KA_k(i) = \sum_{m=1}^{4} \left(\sum_{n=1}^{6} KA_{(m,n)} \right)$$

For example, a learner, *i*, is requesting learners with the proficiency to apply conceptual knowledge of *Software Engineering* to solve problems. Based on the aforementioned equation, this request can be denoted as:

$$BT_{SE}(i)=\begin{bmatrix}0&0&0&0&0&0\\0&0&1&0&0&0\\0&0&0&0&0&0\\0&0&0&0&0&0\end{bmatrix}$$

$$KA_{SE}(i)=KP_{SE}(i)\bullet(BT_{(SE)}(i))$$

$$KA_{SE}(i)=\begin{bmatrix}0.9&0.8&0.4&0.4&0&0\\0.3&0.3&0.2&0.1&0&0\\0.6&0.5&0.3&0.2&0&0\\0&0&0&0&0&0\end{bmatrix}\bullet\begin{bmatrix}0&0&0&0&0&0\\0&0&1&0&0&0\\0&0&0&0&0&0\\0&0&0&0&0&0\end{bmatrix}$$

$$KA_{SE}(i)=\begin{bmatrix}0&0&0&0&0&0\\0&0&0.2&0&0&0\\0&0&0&0&0&0\\0&0&0&0&0&0\end{bmatrix}$$

After the serialization of $KA_{SE}(i)$, $KA_{SE}(i)=$ 0.2

Calculation of social network association

Based on the aforementioned calculations of trust association (TA) and knowledge association (KA), we now proceed to calculate the social network association (SNA) as following:

$$SNA_k(i,j)=KA_k(j)\times TA(i,j)$$

where

$SNA_j(i,j)$ *: Network association between learner i and learner j concerning a specific domain, k*

$KA_k(j)$ *: knowledge association of learner j concerning a specific domain, k*

$TA(i,j)$ *: trust association between learner i and learner j*

Using the example shown in Figure 4, if learner "*a*," is requesting a specific piece of knowledge, learner "*d*" can be more helpful than learner "*c*" because the value of $NA_k(a,d)$ is higher than the value of $NA_k(a,c)$.

$$KA_k(c)=0.8$$
$$TA(a,c)=0.7$$
$$NA_k(a,c)=0.8*0.7=0.56$$

$$KA_k(d)=0.8$$
$$TA(a,d)=0.8$$
$$NA_k(a,d)=0.8*0.8=0.64$$

Experiments and discussion

We have conducted quantitative and qualitative experiments to evaluate the mechanisms and environments presented in this paper. To evaluate the performance of finding quality content via our P2P network, we measured two important indexes, Precision and Recall, and demonstrate that, by using content classification with peer ranking and quality control presented in this paper, our keyword thesaurus and concept map do outperform conventional keyword searches.

Consider a request of document search and its set of relevant documents, and let |*R*| be the number of documents in this set. Assume that a given search method generates a retrieved set of documents, and let |A| be the number of documents in this retrieved set. Let |*Ra*| be the number of documents in the intersection of sets R and A. Precision is defined as *Precision* = |*Ra*| / |*A*|, which is the proportion of retrieved documents that are considered relevant. Recall is defined as *Recall* = |*Ra*| / |*R*|, which is the proportion of relevant documents that have been retrieved. We compared the three search methods, keyword search, keyword thesaurus, and concept map on their search results of five knowledge domains as defined in ACM Computing Classification System, 1998 Version. The results of the experiment are shown in Table 1.

Table 1. Three search methods and their search results of five knowledge domains

	Keyword search		**Keyword thesaurus search**		**Concept map search**	
domain knowledge	Precision	Recall	Precision	Recall	Precision	Recall
e-learning	0.443	0.567	0.814	0.733	0.714	0.833
mobile learning	0.467	0.400	0.633	0.511	0.433	0.600
pervasive learning	0.367	0.443	0.600	0.429	0.541	0.729
ubiquitous learning	0.367	0.450	0.684	0.450	0.431	0.750
situated learning	0.375	0.345	0.645	0.316	0.545	0.716

As indicated in Table 1, for the five given knowledge domains, the Precision of a keyword-thesaurus (KT) search shows better performance than the other two search methods. This indicates that the retrieved contents are mostly relevant because the retrieved documents are the search results for relevant keywords. For the five given knowledge domains, the Recall of a concept map (CM) search shows better performance than the other two search methods. This indicates that most of the relevant content associated with a concept can be retrieved because the search results are based on the main concept and its derived concepts on the concept map.

In addition to the quantitative performance analysis, to evaluate the performance of our P2P-based social network support, we have conducted a qualitative experiment with 56 undergraduate computer-science major students (juniors) enrolled in a class entitles, "Introduction to Knowledge Engineering." All students were required to use the P2P networks and the social network support presented in this paper. Items in the questionnaire were measured based on a five-point Likert scale ranging from (1), "strongly disagree," to (5), "strongly agree." The results of survey items are shown in Table 2.

Table 2. Performance of P2P-based social network support

No.	**Questionnaire**	**Mean**	**SD**
1	Do you think the found collaborators are knowledgeable?	4.24	1.13
2	Are you confident the found collaborators are trustworthy?	4.37	0.78
3	Do you think you can find better collaborators compared with the P2P social network support?	4.56	1.10
4	Are you satisfied with the user interface design?	3.95	0.94
5	Is it easy to form a group discussion by using the support?	3.67	1.28
6	Are you satisfied with the system performance in terms of communication and synchronization?	3.56	0.84
7	Do you think it is important to connect this support to other instant messengers?	4.23	0.62
8	Do you think it is important to have voice-enabled support?	4.37	0.68
9	Do you think it is important to have an e-whiteboard for synchronous file sharing?	4.18	0.61

Table 2 shows that most of the collaborators found by this P2P social network support are knowledgeable and trustworthy. Nevertheless, learners still prefer to choose their own partners even though they thought the collaborators found by the system were knowledgeable and trustworthy. This observation suggests that we need to take into account learners' social relationships in addition to their knowledge competence. Most of the learners thought that the user interface design is very important, and they wished that they could have better control regarding choosing collaborators. We also found that learners wanted to connect to other instant messengers and demanded many real-time functions while they were interacting with other collaborators via voice communication and e-whiteboard for synchronous discussion and file sharing.

Concluding remarks and future research

The objective and contribution of this paper is to apply social networks to enhance the quality of e-learning regarding knowledge sharing in virtual learning community by overcoming two barriers: difficulty in finding quality knowledge and difficulty in finding trustworthy learning collaborators. The results of this research demonstrate that applying such mechanisms to knowledge sharing do improve the quality of e-learning in virtual learning communities. We provide several avenues for further research. It is a general problem in social networks to support the discovery, access, and sharing of knowledge. Further study is needed to investigate the special requirements from different learning contexts in virtual learning communities, such as, for a given time, where are the learners? Who are the learners with? What are the learners doing? And what resources are available for learners? We will consider such context-aware learning in our future research.

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Quality Literacy — Competencies for Quality Development in Education and e-Learning

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ABSTRACT

The article suggests that stakeholders involved in quality development need a specific competence, called quality literacy, in order to successfully improve learning processes. We introduce and describe quality literacy as a set of competencies that are needed for professional quality development. Quality literacy emphasises the importance of professionalism as a necessary component for quality development, in addition to structural quality management models. We argue that quality development is a co-production between learners and their learning environment. This means that the educational process can only be influenced and optimised through participation and not steered externally. Quality strategies cannot, therefore, guarantee a high quality of learning processes but rather aim at professionalisation of the educational process and stakeholders. This article suggests participation and negotiation between educational stakeholders (clients and providers) as a main condition for quality development. In addition, we present a quality model that conceptualises quality as a potential that can only be achieved through interaction.

Keywords

Quality literacy, Participatory quality development, Professionalisation, Co-production, Educational quality, E-learning

Introduction

Quality in e-learning has become a leitmotiv in educational policies, an imperative for practitioners, and a huge demand for learners. Achieving high quality is a much debated and sought-after goal in all segments of education. It is, however, not so much characterized by its precise definition but rather by its positive connotation. The word quality (from the Latin word *qualis*) means “composition” or “characteristic.” In everyday language, however, the term is used to distinguish a characteristic of an object as being of a higher calibre than that of another object. We can observe that the debate is not characterized by empirically accurately defined and operationalized ideas, but is made up of a dense bundle of a broad range of arguments, objectives, convictions, and procedures.

The search for quality in e-learning and education is often addressed in the way of finding a suitable approach for controlling or steering the pedagogical process. Yet, this view ignores the fact that the relation between cause and effect in the field of pedagogical practice is rather open and insecure (cf. Fink, 2003; Moslehian, 2003; Taylor, 2004). It is one of the few secured results of educational research so far that pedagogical practice is much more characterized by insecurities and situational interpretations than through systematic cause-effect relations (cf. Oelkers, 1982). Because of this reason, Luhmann and Schorr (1982) attribute to pedagogy a “technological deficit.” In particular, psychologically oriented e-learning research tried for some time to determine the exact cause-effect relation between e-media attributes (screen colours, length of dynamic learning objects, etc.) and learners’ learning progress in order to derive consequences for the design of learning environments. (For an overview of these attempts see Ehlers, 2004). However, such research designs proved to be too complex, and we can conclude that, not the media characteristics alone, but rather the underlying learning methodology and instructional arrangement facilitate learning success (cf. Russel, 1999). Today it is clear that knowledge, information, and learning media do not have an inherent learning quality but rather carry a quality potential, which has to be released in co-construction processes during the learning phase. This process is highly influenced by the learners themselves (cf. Friend-Pereira, Lutz, & Heerens, 2002). In this article, we therefore argue for a new understanding of quality development in education and e-learning.

Quality development should not rely solely on structural models and strategies but take into consideration the professionalization of quality development — especially in light of its technological deficit. The main assumption of this article is that there are certain competencies for professional-quality development, and that these apply to both the learner/client side and the teacher/provider side. Quality development in education is viewed as the result of quality competence of the involved stakeholders. This competence is termed *quality* *literacy*. It is viewed as a critical factor for success of every quality-development activity in education. The concept builds on earlier work (cf. Ehlers, 2005) and develops a theoretical foundation based upon educational theories and terminology for the concept of quality literacy. The scope, the validity of described concepts, and the reach of this concept have to be understood within this theoretical framework. Quality development is defined, from an educational point of view, as a co-production and a participative concept. Evidently, a theoretical contribution with this focus has restrictions in scope: Economic and/or technological models are not integrated into the argument.

Next section describes the context and conditions for the concept of quality literacy by using a categorization of the term "quality" taken from the sector of service quality. It is argued that education has to be conceptualized in form of a pro-sumption rather than a production-consumption relationship, and takes place in participation. Building on this thought, the section introduces the notion of participative quality development as a pre-condition for educational quality development (See the section on participation and co-production as conditions for educational quality development). We stress that the ultimate goal of quality development processes has to be the incorporation of new or changed procedures, rules, and values of the educational actors.

Section three introduces and elaborates upon the concept of quality literacy. First we give the general background and scope of the concept as well as the methodology used to derive the concept from already existing theoretical works and conceptual backgrounds. Moreover, we describe in detail a set of competencies that are necessary to perform improvement processes based on the outlined conditions for quality development in education. We emphasise that quality literacy is much related to the concept of total quality management. It is defined as the individual ability needed to develop and implement a culture of quality as an ongoing improvement process.

Section four relates quality literacy to a model of interactive and participative quality development. It is taken from the field of service quality development and adapted to the field of educational quality development. The concept of quality literacy is described as the basic competence to perform the necessary actions that are suggested and described for both providers and clients within the presented quality model.

The conclusion (**section five**) suggests that the result of an educational process cannot directly be influenced and optimized like a production process. It is argued that quality strategies, therefore, cannot mechanistically guarantee high quality of learning processes but should aim rather at a professionalization of the pedagogical process — for both clients and providers. The quality literacy concept is a step in the direction of professionalizing quality development in this sense. Finally, some research issues are suggested which can be seen as desiderata in the frame of the formulated concept.

Although e-learning is the general context in which the concept of quality literacy has been developed, we do not distinguish between education and e-learning in this article. The term we use is "education." We believe that e-learning is an educational innovation and has a number of specific challenges to it (cf. Seufert & Euler, 2002). When introduced to educational scenarios, it often functions like a magnifying glass and reveals immediately deficits in pedagogical planning or teaching/learning organization. However, the concept is of a generic nature and addresses quality development issues from their very core — and thus does not make a distinction between "e"-learning as the field of quality development and "non-e"-learning. Although there are a number of specific challenges which differ between e-learning and non-e-learning, it is argued that the concept of quality literacy addresses issues that are the same in both fields. In this sense, the concept is a generic concept and is equally applicable to the field of e-learning vs. education as well as to the different educational sectors.

Section two: Quality in education

In this section the main conditions for quality development in education are described. It is suggested that quality development is a constant negotiation process in which all stakeholders should participate in a common effort to define and implement quality in a continuous, improved way. It is this specific characteristic of educational quality as a *relation* rather than a *product*, and connected to it, the ever-present debate and fundamental question about the relation of "imparting" education vs. self-organization of educational processes (cf. Fink, 2003; Taylor, 2004) that demands a specific competence in the quality development process. In order to empower the individual actor in the educational process — be it as teachers or learners — and to orient every educational interaction towards improvement, the actors have to be *quality literate*.

In this section, two characteristics of educational quality development are described: the multidimensional nature of quality in education, and the need for rethinking quality as a participatory process that must be facilitated as a co-production between educational stakeholders. Both aspects emphasise that continuous improvement processes in education are of an unforeseeable and dynamic nature, which demands a certain ability of the involved actors to respond to these challenges. This ability is described as a competence rather than as a reproducible knowledge. (See **Quality literacy: Competencies for quality development** for elaboration of this distinction.)

Quality as a multidimensional concept

Quality in education is a multidimensional concept (cf. Donabedian, 1980; Ehlers, 2004). Therefore, different approaches to define quality are available (cf. Quartapelle & Larsen, 1996). Berkel (1998) suggests a three-dimensional scheme, originally for service quality, which has been adapted to the field of educational processes in the following description. It locates quality within three poles (ibid., p. 19):

- objective vs. subjective: This dimension addresses the question of who is defining quality criteria and values. If the quality value is defined only through the performance indicators of a product, Berkel (1987) terms it objective quality. The quality characteristics then have to be a part of the respective good, which is only partially true for the field of education. For education, the quality characteristics are usually defined through individual persons or committees in a subjective way. The definition of quality requirements through clients or learners is a subjective quality definition.
- inherent vs. instrumental: This dimension relates to the questions of where quality can be observed and when it becomes explicitly measurable. Inherent quality relates to the quality of a product that can be observed as lasting and innate. If quality reveals itself only through a service process, and thus the participation of clients, we refer to it as an instrumental quality. Often objects with inherent quality characteristics (e.g., Learning Management Systems, learning materials, etc.) are used in an instrumental way.
- endogenous vs. exogenous: If organizational processes and structures are taken into account when evaluating and/or assuring educational quality, we say they are of endogenous quality. If the educational institutions or organizations are not part of a quality evaluation, we say they are of exogenous quality. The quality evaluation of education requires an active process. Endogenous and exogenous can be used to distinguish between quality assessments that are either directed to the surface structure (exogenous) or to the deep process structure (endogenous) of an educational service.

According to Berkel's (1998) distinction, the quality of education is subjective, instrumental, and endogenous. It reveals that quality in education is a client-oriented concept in which the quality requirements are defined in participation between clients and providers. The quality of education is therefore constituted only through mutual interaction of learners with their learning environment (cf. Brindley, Walti, & Zwaki-Richter, 2004), and the evaluation of quality is influenced by organizational processes within which the educational process takes place (endogenous).

Participation and co-production as conditions for educational quality development

Classical service theory conceptualises the interactive relationships between the actors of people-oriented services and the categories "production" and "consumption" (cf. Gross & Badura, 1977). It is argued that education is a symbolically mediated, productive-active interaction as well as a production process. This process involves learners together with other actors (learners, teachers, etc.). It therefore has to be conceptualized in the form of a pro-sumption rather than a production-consumption relationship (cf. Martens & Prosser, 1998). The addressees of educational services are therefore conceptualized as active "co-producers" and not as passive receptors. According to Meyer and Mattmüller (1987), services are thus not defined by an absolute quality, but rather by their quality potential, and can only release this potential through the active involvement of the client. Le Preau (2005) even stressed that quality can only be defined through taking into account the view of as many stakeholders as possible. He refers to the stakeholders of education as quality experts.

A parallel can be drawn here to newer approaches of change management in organizations. Doppler and Lauterburg (2005) describe the importance of flat hierarchies in organizations and the importance of individual empowerment and competence development of the organizations' actors for constant adaptation processes to a changing environment. Hiatt and Creasey (2003) and Champy (1995) emphasise in their approach the role of the individual actor for change processes in organizations. It has to be noted that in all these approaches, the ability of individuals to competently engage in and self-organise change processes is emphasised as strongly as structural management issues (cf. Hall & Hord, 2001). Organizational change and learning thus relies on individual change (cf. Boyce 2003).

For the design of high-quality learning environments, this view bears some consequences: Learning environments — a term that is used here in the broad sense, referring to the sum of all processes that constitute the learning opportunity and including all resources and persons that are part of it — have to be designed in a way that makes it possible for learners to express their demands and preferences as part of the construction process. Only then can learners bring forth their experience, backgrounds, and demands, thus enabling providers to design learning environments in a way that allows active learning, problem solving, and competence development oriented towards the learners' individual needs. The assurance of quality exclusively reached through predefined, static frameworks (e.g., standard evaluation questionnaires) often does not sufficiently address this particular necessity of co-production in educational settings (cf. Baijnath & Singh, 2001; Freesen, 2002). From this perspective, it is important that the development of quality strategies takes into account an active negotiation process as a specific condition of quality development and supports it proactively. Quality management concepts therefore have to include a negotiation component. This requires an extended understanding of process-oriented quality-development models, and asks for competence development and staff professionalization components within quality strategies.

From a socio-structural point of view we can moreover observe that clients' identity structures change and standard biographies become more and more heterogeneous, and therefore lose their prognostic value for planning educational processes (cf. Beck, 1986). Quality concepts that are still based on concepts of traditional biographies are losing their analytic powers over educational processes. If the described necessity of individualization of educational processes is taken seriously, then it is difficult to formulate fixed and prescriptive quality standards for progressively heterogeneous situations. They have to be compared to flexible negotiation frameworks that allow consideration of the learners' situation and perspective in a co-productive process (cf. Pruitt & Carnevale, 1993). To use a participatory quality strategy means to support or hinder negotiation processes but not to substitute them through management processes any longer.

Section three: Quality literacy — competencies for quality development

The concept of quality literacy is based on the assumption that quality in education is the result of competent behaviour of stakeholders involved in an attempt to develop quality. The scientific approach that is used to derive the concept of quality literacy builds on the concept of Total Quality Management as described by Horine and Lindgren (1995) and applies the concept of Media Literacy as formulated by Baacke (1996) to the field of quality development. This application is done on the theoretical basis of the concept of action competence relating to elaborations of Weinert (1999) and van der Blij (2002) and also taking into account the connection between knowledge, skills, and competence according to North (1998, 2005). In this section we describe the theoretical background of the concept and the methodology that has been used to construct the concept of quality literacy. We define a set of skills that are necessary to perform quality development processes. The concept is embedded in the view that quality has to be defined in a participatory way (see section two).

Theoretical Background and approach of a new Concept

Quality literacy is a concept that is much related to the philosophy of total quality management. Within this approach, quality is seen as a continuous improvement process, involving all stakeholders in the process of a permanent assessment and quality improvement (cf. Horine & Lindgren, 1995). One element is of key importance — the introduction and development of a quality culture into an organization. This has two dimensions (fig. 1). First, a managerial dimension that is of a rather technocratic nature and deals with implementing tools and instruments to measure, evaluate, enhance, and assure quality. This is usually facilitated though a top-down process. Second, a dimension of quality commitment focuses on an individual level. It relates to the individual commitment to strive for quality, using tools and instruments for quality development. First and foremost, however, it focuses on changing attitudes and values, and developing new skills and competencies in order to make a permanent improvement of quality possible. Individual abilities, attitudes, and values add up to a collective level, which in turn leads to a quality competent organization. This dimension relates to a bottom-up process.

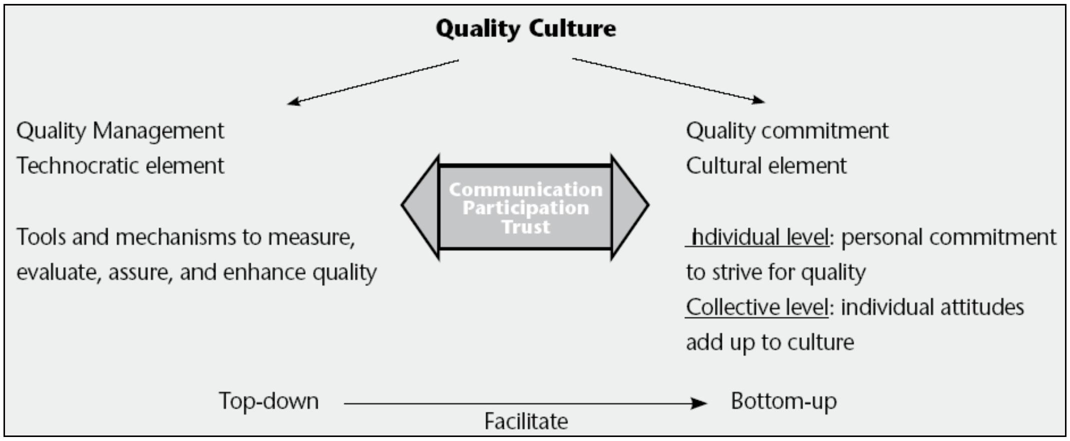

Figure 1. Quality culture (European Universities Association, 2006)

The ability for an individual to competently use, modify, and further develop existing tools, instruments, and strategies, or to introduce them or develop them new in order to pursue a permanent quality orientation in an educational setting shall be called quality literacy. Quality literacy is not a free-floating concept, but can be rooted in and connected to many already long-existing theories and approaches. We derive the term originally from the concept of media literacy as it was formulated by Baacke (1996). Baacke suggested conceptualizing media literacy as an ability with four dimensions: media knowledge, media critics, media usage, and media design (ibid.). As a concept, media literacy describes the abilities that individuals need to act competently in a world mediated through media. From a methodological point of view, we transfer the four dimensions of media literacy and reformulate them for specific application in the field of quality development. Quality literacy thus describes the abilities that individuals need to act competently in quality-development processes. The use of a conceptual transfer methodology from one field to another demands clear definition of the related concepts and a comprehensive description of the fields they apply to.

In an organizational context, quality literacy is a set of skills that enables individuals to take part in the development of a quality culture. For individual learners, the same set of skills enables them to pursue permanent improvement processes of their own learning and development processes, using quality instruments and concepts. Quality literacy thus applies to both sides — actors on the providers' side of educational processes (teachers, tutors, media designers, or administrative staff) and actors on the clients' side of educational processes (learners). It is a set of generic skills that applies in both contexts and has to be adapted to the specific situation.

This concept is comprehensively introduced in this article for the first time. It is based on the belief that quality improvement is the result of the(quality) competent action of individuals. It is of complementary nature to external organizational quality strategies that are seen as an important but not sufficient component for achieving high quality in education. Quality literacy manifests itself in the ability of actors of an organization or of an individual learner to use quality strategies and tools, and incorporate the changed and new beliefs and values they inherently carry into their everyday professional behaviour and procedures. Only then will educational quality development be successful.

A set of individual competencies necessary for this purpose can be described and are captured in the concept of quality literacy. Although the concept is fairly new, it has counterparts in other areas that follow a similar pattern. For the field of organizational learning, for example, Peter Senge (1990) describes a set of five competencies that he introduces as important for all forms of organizational learning. He stresses that not only must external strategies, procedures, and rules be implemented into organizational change processes, but that the actors have to take on new ways of thinking and acting and thus have to become competent facilitators of change.

The concept is entitled quality "literacy" because not only does it relate to *knowledge* about quality but goes beyond this, towards the concept of *competencies*. It goes back to the theoretical approach of action competence, which is defined as the ability of self-organization in a specific educational or professional context (Weinert, 1999). One important assumption in this model is that competencies can be learned and developed through practical activity. The necessity of an active, self-organized learning process is stressed, and competencies cannot be taught through a purely instructional approach. Van der Blij (2002) stresses the importance of knowledge, skills, and attitudes for competencies: "Competence is defined as the ability to act within a given context in a responsible and adequate way, while integrating complex knowledge, skills, and attitudes." Wildts (2006) adapts the concept of Competence Steps of North (1998, 2005) to show the link between knowledge, skills, competence, and professionalism (fig. 2).

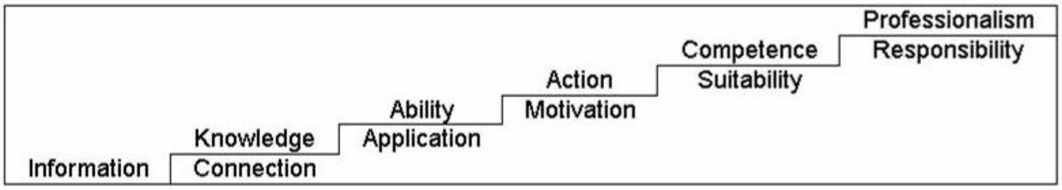

Figure 2. Steps to professional competence (adapted from Wildt 2006)

Quality Literacy in this sense is seen as a basic prerequisite to acting professionally in quality development contexts. On the first step, information about quality and quality development or related fields is interconnected and linked to knowledge. On the second step, they are applied and result in abilities. This is the step where individuals have practical experiences with applying or using quality strategies, tools, or instruments. These abilities are transformed in activities through motivation and will. Competence, however, demands an additional evaluation about whether the performed activity is suitable in a given context. For this, an individual usually needs standards against which he or she can assess whether something is suitable in a specific context. For quality development, these can be societal norms, legal rules, criteria that are agreed on in the specific organizational context, or set of standards for individual behaviour. Wildt (2006) extends North's concept by including the step professionalism*,* which relates to the responsibility towards clients and society. Quality literacy, therefore, is more than knowledge or abilities.

In general, it has to be noted that quality literacy applies to all forms of knowledge, information, and learning of technology-related educational concepts, such as e-learning, blended learning, and presence courses. There are commonalities and differences between "traditional" educational scenarios and e-learning. Concerning quality development, however, we have to note that it is a process of negotiation with the goal of providing successful education in both educational fields. For e-learning, we additionally have to deal with the specific field of technology. Of course, additional areas of knowledge apply here. In principle, however, quality development requires the same competencies.

In conclusion, we can state that the concept of quality literacy builds upon existing concepts and aims to describe skills that enable individuals to perform quality development competently. Sometimes these situations are very complex (e.g., when it comes to restructuring whole organizational processes). Sometimes, though, there is little complexity when only one specific quality instrument is applied to perform quality assurance (e.g., a questionnaire at the end of a program or course). Quality literacy, moreover, is a concept that cannot exclusively be learned by means of books or training, but requires experience and practice. It is a concept that is subject to constant change, as the means and forms of technology-enhanced education change as well.

The four dimensions of quality literacy

Quality literacy (fig. 3) can be seen as a set of four central competencies that contribute to carrying out successful quality development in education. They do not constitute distinct factors of quality literacy, but rather differentiate the inner structure of the concept of quality literacy. A more precise description of the inner structure and coverage of the concept is presented and elaborates upon the four dimensions the concept contains.

Dimension one: Quality knowledge

This dimension addresses the "pure" knowledge about the possibilities of today's quality development and up-to-date quality strategies in e-learning and education. The term "quality strategies" refers to all guidelines, structures, rules, tools, checklists, or other measures that have the goal of enhancing the quality of an e-learning-scenario. There are two sub-dimensions to quality knowledge: informational and instrumental, which go back to Ryle's (1949) classification of "knowing that" and "knowing how."

a) **informative:** The informational dimension refers to information and knowledge about quality systems, tools, and procedures. It is about having access to information resources, primary as well as secondary, and understanding the system of quality development. Typical examples of this are questions such as: What is a quality approach? What is evaluation? quality management? quality assurance? quality development?
b) **instrumental:** The instrumental dimension refers to the knowledge of how to use and apply a specific tool, such as an evaluation questionnaire, or how to use a list of criteria or guidelines for a specific context. The

instrumental dimension answers questions such as the following: How can an evaluation questionnaire be applied in an educational context such as a classroom? How can a set of benchmarks be used to compare my system to another one? The instrumental dimension does not, however, relate to the competence of implementing a quality system with a certain intention, such as reducing a course's drop-out rate. That is covered through the dimension of quality experience.

Dimension two: Quality experience
This dimension describes the ability to use quality strategies with a certain intention. It is based on the experiences that actors have with quality development and with applying quality measures and strategies to educational scenarios. It can be differentiated from the instrumental knowledge dimension because it refers not only to the pure application of quality strategies or tools but also covers the processes of feedback analysis and initiating improvement. That means that, in addition to the instrumental knowledge of quality strategies, this dimension also carries with it an intention and a goal. Quality experience refers to the ability to use (existing) quality strategies (e.g., guidance and consulting concepts) to generate data about educational processes in order to improve them. It answers questions such as: How can I use quality strategies in a certain way to improve the educational process?

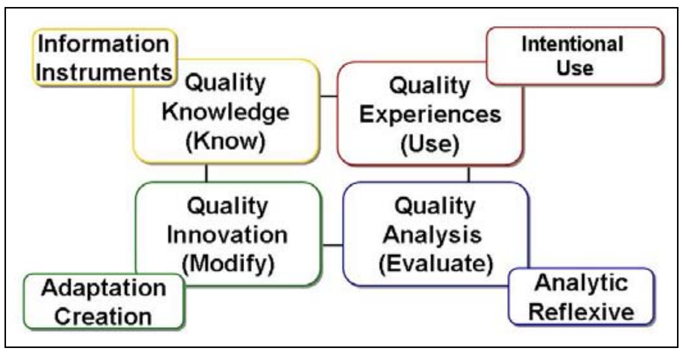

Figure 3. Dimensions of quality literacy (QL)

Dimension three: Quality innovation
This dimension relates to the ability that goes beyond the simple use of existing instruments and strategies. It refers to the modification, creation, and development of quality strategies and/or instruments for one's own purpose. An innovative and creative aspect is important for this dimension. Within this dimension, "adaptation" and "creativity" mean further development and reorganization of existing quality strategies within a given context. "Innovation" means thinking up and developing new strategies for quality development.

a) **Adaptation**: This sub-dimension refers to the ability to adapt an existing quality strategy or tool to one's own context. It goes beyond the pure usage of an existing tool, requires deeper understanding of it within the given methodological framework, and demands creativity. A typical question is: How can a certain quality management concept be extended to a number of processes and categories in order to adapt it to the organization's specific needs?
b) **Creation/innovation**: The creation/innovation dimension describes the ability to think beyond existing strategies and go further than just modifying them. It also describes the ability to invent a complete new quality system. Such self-developed systems are often used for an organization's internal purposes when existing approaches do not cover the specific goals and requirements. An example would be the development of a new evaluation questionnaire for the assessment of a course when existing tools fail to analyse the desired aspects. Also, it could be the development of a new method of consultation with learners before a course starts in order to assess their needs and goals.

Dimension four: Quality analysis
Quality Analysis relates to the ability to critically analyse the processes of quality development in light of one's own experiences and to reflect upon one's own situation and context. It enables actors to evaluate different objectives of quality development and negotiate between different perspectives of stakeholders. To critically analyse means to differentiate between and reflect upon existing knowledge and experiences in light of quality-development challenges. For learners, this means being aware of their responsibility for quality in education as a co-producer of learning success. For providers, this means enabling flexible negotiation processes in educational offerings and respecting individual objectives and preferences as well as societal contexts and organizational structures in their definition of quality objectives for education. Two sub-dimensions can be differentiated: analytic and reflexive.

a) **Analytic Quality Analysis:** The analytic dimension covers the process of analytically examining the meaning and the debate of quality in education in general. It is the ability to move within the framework of quality discourse, to contribute analysis, and to understand the different influences, starting from the market perspective and business models, taking into account technical aspects, and not forgetting the pedagogical aspects. Analytic quality analysis answers the question: What is the state of quality discussion and what are important developments in the debate?
b) **Reflexive Quality Analysis:** The reflexive dimension is directed towards the analysis of one's own situation. It is the ability to set quality goals for one's own individual or organizational context, and to position oneself in the quality debate. The reflexive dimension emphasises the ability to understand future challenges in educational quality development, rethinking one's current quality situation, and developing a strategy to meet future challenges. A typical field of the reflexive quality analysis competence is the development of future goals, leitmotivs, and strategies either for oneself as the individual learner or for an organization.

Table 1 summarizes the different components of quality literacy and gives an overview of the questions that they relate to.

Table 1. Overview of different components of quality literacy

Quality Literacy Dimension	Questions/Examples
Dimension 1: Quality Knowledge	
Information	What is a quality approach? What is evaluation? quality management? quality assurance? quality development?
Instrumental/Qualification	How can an evaluation questionnaire be applied in an educational context, such as a classroom? How can a benchmark be used to compare one system to another?
Dimension 2: Quality Experience	
Intentional Use	How can I use quality strategies to improve the educational process?
Dimension 3: Quality Innovation	
Adaptation	How can a certain quality management concept be extended to a number of processes and categories and adapt to the organizations' specific needs?
Creation/Innovation	Create an evaluation questionnaire for the assessment of a course when existing tools fail to analyse the desired questions. Create a new method to consult with learners before a course starts in order to assess their needs and goals.
Dimension 4: Quality Analysis	
Analytic Quality Analysis	What is the state of quality discussion and what are important developments in the debate?
Reflexive Quality Analysis	Development of future goals and strategies for either oneself as an individual learner or as an organization.

Section four: Participative model for quality development

In the following section, we present a quality model that shows the interactive nature of quality development in education (fig. 4). It is a model of Meyer and Mattmüller (1987) that is taken from the field of service quality and adapted to the context of education. The above-described characteristics of quality development and the suggested concept of quality literacy are connected to this model. The model shows that quality is at first only a potential that has to be realised through mutual negotiation and stocktaking of providers and clients. It combines the quality process distinction from the work of Donabedian (1980) with concepts from Grönroos (1984), and divides quality into three processes: potential, process, and outcome quality. These are each differentiated for the provider side and the client side. In figure 4 the model is extended by adding phase categories: a) needs analysis, b) realisation, and c) incorporation. For each phase, the concept of quality literacy applies in a different way.

Potential quality/needs-analysis phase

In this phase, the need for quality, situation, and context of the educational scenario is subject to examination. The potential quality of the provider is characterized by the capacity of its staff and the potential of its equipment, materials, and infrastructure. The specification potential is the provider's ability to react to the client's individual needs and preferences in order to provide the appropriate educational environment. The contact potential is the ability to enter into a negotiation process with the client. It relates to expertise in the field of pedagogic-diagnostic abilities and also covers the means of communication and contact possibilities. The contact potential aims at building trust with clients and establishing the basis for negotiation of the educational provision. All in all, the potential quality of the provider is about its capacity to interact with clients and react to their needs.

The model also sees a potential quality on the side of the client: The term integration potential points to the ability of clients to assess their needs and their capacity to self-reflect and analyse. What this means is that the model allocates to the client part of the responsibility for the quality of educational processes. It gives importance to the fact that clients/learners have to be aware of their own needs and preferences in order to enter into a high-quality learning opportunity created in collaboration between themselves and the provider. A precise exploration of the integration potential by the provider can influence the educational provision enormously. Furthermore, the interaction potential describes the client's abilities to contribute his or her part to a constructive negotiation process and to become part of a participative definition of educational quality. The client's background, former experiences, and abilities to express his or her needs are influential categories for this potential.

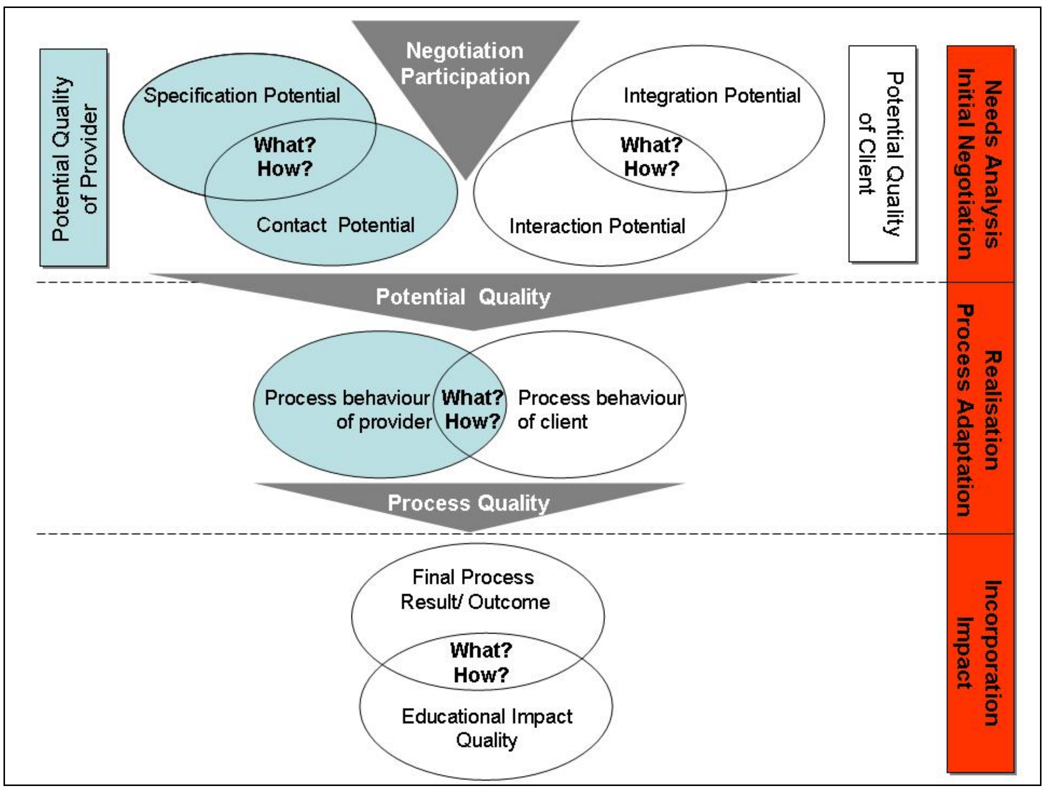

Figure 4. Participative model for quality development (adaptation of Meyer and Mattmüller, 1987)

Stakeholders who are involved in these processes need the capacity to evaluate and define the needs of all stakeholders involved in the educational scenario and negotiate among themselves to achieve a high-quality learning environment (Quality Analysis). Additionally, knowledge about the possibilities of quality development and about quality strategies or good practice examples could be of help in the needs analysis phase.

The needs analysis phase leads to a decision for a quality strategy. For this, Quality Knowledge is needed. If none of the available strategies meet the identified requirements, a new quality strategy has to be developed. For this, two competencies are especially important: quality knowledge and quality analysis. When it comes to developing an individual strategy, the ability of quality innovation (i.e., creatively and innovatively developing a fitting quality strategy) gains importance.

Process quality/realisation and process adaptation phase

In the realisation phase, a quality strategy that corresponds to the analysed needs is implemented into an organisation and continuously adapted to the organisation's specific needs. The process quality is the result of interaction between the clients and the learning environment. The model (fig. 4) shows that each partial quality is divided into two parts. This model relates back to the work of Grönroos (1984), who differentiates between "what" the client and the provider co-construct and "how" they co-construct it. An interesting notion of Grönroos' concepts is the emphasis that, apart from the purely functional process of providing a service, for all partial qualities the emotional, that is, the human service quality ,is an influential factor. However, this is difficult to conceptualize into an operational model. Also, Lethinen and Lethinen (1991) refer to these qualities and name them "physical quality" and "interactive quality."

In the realisation phase, quality instruments and tools can be used. The usage of models and instruments for quality development tools such as checklists, process descriptions, and/or evaluation questionnaires, requires a high number of quality experiences. The adaptation of these instruments and models demands a capacity for innovation and modification and is conceptualized in the dimension of quality innovation. Critical analysis and assessment form an integral part of this phase. Quality analysis thus becomes important.

Outcome Quality/ Incorporation and Impact Phase

Quality development — in the end — is always directed toward the modification of the behaviour of individual actors of an organisation, its tutors or teachers, or the course authors, etc. The incorporation phase relates to the actual impact, that is, the outcome of quality development. In the quality model (fig. 4), the resulting quality represents the educational impact evoked through the process of co-construction of the educational opportunities. Meyer and Mattmüller (1987) subdivide this quality component into one part, which is immediately recognizable, and another part, which is the long-term impact quality. For educational processes this division into two types of results is important because often the long-term results are more valuable than the short-term effects (e.g., the competencies that can be used when the employee is back to his or her workplace).

This phase concentrates on the actual effect of quality strategies. "Incorporation" in this context means that the new values, norms, and concepts that are inherent in newly introduced quality concepts have to be incorporated by the actors who use them. They have to have an effect on the actors' everyday professional behaviour. For example, it is not only important that an evaluation questionnaire has been selected and distributed, and that the feedback has been analysed, it is equally important that the results have an impact on the educational process. In the incorporation phase, therefore, we examine whether the changed processes and new values suggested through a new quality strategy are incorporated into the activity patterns of the stakeholders. Critical analysis skills and evaluation experiences are necessary for this phase. Quality Analysis is therefore crucial in this phase.

Table 2 gives an overview on the relevant questions that are addressed for each of the partial qualities.

Table 2: Description of partial qualities of the participatory model for quality development (adapted from Meyer and Mattmüller, 1987)

Potential Quality of Provider	**Specification Potential**	- Which learning opportunities and boundaries does the educational offer contain with regard to the individual situation and preference of the client? (Is it possible to choose time, place, teachers, learning groups, learning environments?) - How is the educational environment adapted to the individual characteristics and preferences of the client?
	Contact Potential	- How can clients specify their learning needs? (e-communication means, office hours, educational counselling offers, etc.) - How competent are the contact persons? (diagnostic abilities, flexibility, communicative competencies, etc.)
Potential Quality of Client	**Integration Potential**	- What are the expectations and needs of the client? - What is the client's attitude and preference towards the educational experience? - What does the educational experience mean for the client?
		- How good is the client's capacity to integrate/communicate his or her

	Interaction Potential	needs into the educational context? (communicative abilities, self-reflection processes, self-diagnostic abilities, etc.) - What is the client's situation and background? - Can the client enter into a beneficial educational process?
Process Quality	**Process Behaviour of Provider**	- How is the educational experience structured? - How is the educational environment realised? - Where are strengths and weaknesses in the educational provision?
	Process Behaviour of Client	- How can the client benefit from the provided educational opportunities? - Where are the client's strengths and weaknesses in the educational process? (learning problems, misunderstandings, etc.)
Final Process Result	**Final Process Result**	- Which procedures are used to determine the final process quality? - How are these procedures applied?
	Educational Impact	- What is the educational impact for the client (e.g., in the workplace)? - Is there guidance/tutoring provided even after the course has ended?

The questions reveal that all partial qualities require differentiated competencies in order to be realised. The quality of all phases is then the result of quality-competent behaviour. The presented quality model is of heuristic value. It combines the different partial qualities with the phases of introducing a quality strategy and helps to differentiate them from each other. The model, which is originally constructed for the field of service quality, has been adapted to the field of educational provision. This adaptation shows that it can combine the different concepts mentioned before: co-construction, participation, and quality literacy, within one model.

Conclusion

Quality development in e-learning aims to improve educational processes. These are the result of a co-production between learners and their learning environments, and in principle cannot be defined prescriptively. This means that in the end, the result of an educational process cannot directly be influenced and optimised like a production process (this relates to the technology deficit of education mentioned in the introduction). Quality strategies therefore cannot guarantee high-quality learning processes but should rather aim to the professionalise the quality development process, both on the client's side and on the provider's side.

This paper emphasises this aspect and identifies a set of competencies that are relevant for such a professionalisation of quality development processes:

a) **Quality knowledge**: This dimension addresses the "pure" knowledge of the possibilities of today's quality development and up-to-date quality strategies in e-learning and education.
b) **Quality experience**: This dimension describes the ability to use quality strategies with a certain intention (e.g., to decrease the drop-out rate of a university program). It is based on the experiences that actors have with quality development and the application of quality strategies to educational scenarios.
c) **Quality innovation**: This dimension relates to the ability to create and develop quality strategies and/or instruments for one's own purpose. It goes beyond the simple use of existing instruments and strategies.
d) **Quality analysis**: Quality analysis relates to the ability to critically analyse the processes of quality development in light of one's own situation and to reflect upon one's own objectives and context.

The interactive nature of quality development is reflected in the presented quality model (see section 4), which subdivides quality into three partial qualities: the potential quality, the process quality, and the outcome quality. The potential quality of the provider and the client has to be realised through interaction and negotiation. Potentials are then turned into (educational) processes. The process quality in turn leads to results, and the outcome quality aims to have a long-term impact. This threefold structure is directly connected to a typical quality development process with a needs analysis phase, a realisation/adaptation phase, and an incorporation/impact phase. Quality literacy is suggested as a set of abilities that give specific support to all phases. In conclusion, we would like to stress that quality development runs the risk of remaining a purely technocratic process when it is not linked to a process of professionalisation of the stakeholders.

The quality model relates to theoretical work that has been done in the field of service quality and combines it with concepts of negotiation, participation, and co-production. However, a comprehensive empirical validation of the described concepts has so far not been undertaken. Therefore we suggest developing empirical research questions in the following fields:

1. Exploration of suitable negotiation and participation methods to involve clients and providers in the development of quality strategies. Who can be involved into negotiation processes? What can be objects of negotiation? What are the quality standards in negotiation processes?
2. Exploration, validation, and formulation of the concept of quality literacy within the framework of total quality management concepts. Quality literacy has to be validated as a concept that enables stakeholders to formulate their own positions and to select and apply suitable quality strategies against the background of their own personal goals as well as their organisation's quality goals.

In an educational setting, quality literacy is a prerequisite for quality development for both the client and the provider. The described competencies allow clients and providers to act in a competent way in the field of quality development and to enter into a process of stimulating a quality culture with the aim of continuous improvement. Enhancing competence is a move toward professionalisation of the quality debate.

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E-learning Quality Standards for Consumer Protection and Consumer Confidence: A Canadian Case Study in E-learning Quality Assurance

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ABSTRACT

Emerging concerns about quality of e-learning products and services animated a project in Canada to create quality standards that derived primarily from the needs of consumer, that could be used to guide the development and choice of e-learning at all levels of education and training, and that could be implemented in a simple manner. A set of quality standards were created to reflect best practices in learning technologies, distance learning, and student-centred learning. The standards, first labeled the Canadian Recommended E-Learning Guidelines, are now available in the Creative Commons as the Open eQuality Learning Standards. To implement the standards, two tools were created: a Consumer's Guide to E-learning and a certification mark — the eQcheck quality mark — to indicate that e-learning courses, modules, and programs, and elements of them, meet those quality standards. The purpose is to provide consumer confidence in the e-learning enterprise and consumer protection for the investments made by individuals, agencies, and entire governments. This approach, a Canadian case study in e-learning quality assurance, differs substantially from other e-learning quality initiatives, making a unique contribution to the e-learning quality assurance dialogue.

Keywords

Quality standard, Consumer-based quality assurance, Quality mark, E-learning quality, Quality certification

Introduction

This article describes an approach to e-learning quality assurance that originated in Canada. As the e-learning enterprise began to develop in Canada, it was recognized that quality would be an issue for both providers and consumers of e-learning products and services. This article, then, sets out the rationale for this project, the process that was followed in creating the Canadian Recommended E-learning Guidelines, the underlying concepts and principles, the actual standards, and the approach taken to implementing them — a Canadian case study in e-learning quality assurance aimed at the global e-learning enterprise.

The global e-learning enterprise

E-learning is one of the primary new products/services in the global knowledge economy. Worldwide, businesses and public-sector agencies are producing and marketing e-learning products/services in a very competitive marketplace; and on a global basis, individuals, corporations, and governments are using e-learning products at an increasing rate. Current estimates by Industry Canada indicate that there are more than 5,000 companies worldwide engaged in online learning. Brandon-Hall determined that the e-training industry in the US would grow to US$83.1 billion by 2006. In Canada in 2002, students could access 66,107 courses from 36 countries or 1,952 institutions.

For all these courses and institutions, there was no quality assurance mechanism to protect consumers and students (Barker, 2003; Parker, 2004). Although many prestigious education institutions and businesses began to provide e-learning, there was and is no discernable or defensible connection between the institution's reputation and the quality of the e-learning. The development and marketing of e-learning has become an enterprise that is continuously changing and which is totally unregulated.

For purposes of this quality assurance initiative, the term e-learning is used to mean learning using both a computer and the Internet. E-learning products or services take various forms. They may be single courses and/or entire programs; entire courses and/or course units, lessons, or components; or elements of an e-learning package, for example, a learning management system. The e-learning may be offered for credit at an education institution and/or for general interest without credit, aimed at individuals or entire groups in classes, aimed at specific age groups and/or any age group, and offered by public and/or commercial education and training agencies.

Consumers of e-learning may be individual students, schools boards, education and training departments of governments, and corporations. Providers may be publicly-funded schools, universities, and colleges, or they may be private enterprises producing portions of e-learning from content, design, and production, the delivery and management of learning, and/or the management of students. From the purchaser's perspective, the e-learning service may be very expensive or free of charge; really effective or of questionable quality. Both providers and consumers of e-learning want education and training products and services that are effective and efficient (Barker, 1999). The term quality is used to encompass these concepts; however, the defining and measuring quality in e-learning presents an ongoing dilemma (Abrioux, 2004; Parker, 2004).

With these basic premises, e-learning experts in Canada and from the Commonwealth of Learning began the process of creating a quality assurance mechanism for e-learning, a project that culminated with a full set of standards of excellence in e-learning endorsed by the e-learning community in Canada. The standards, originally labeled the Canadian Recommended E-learning Guidelines (CanREGs), have subsequently been launched in the global e-learning community as the Open eQuality Learning Standards, with the addition of ePortfolio Quality Standards (Barker, 2004). These market-oriented quality standards are important for two significant reasons. First, they help purchasers, through criteria and standards, to make appropriate e-learning choices in order to maximize return on their investment. There are vast numbers and types of e-learning opportunities available to students, options that are highly variable and totally unregulated in terms of price, utility, and quality. Second, they help those who develop and offer e-learning. Colleges, universities, and private enterprise need quality standards and certification in order to meet consumer expectations and to sustain the e-learning enterprise worldwide. Formal e-learning standards, including technical and interoperability standards, assist developers in the same way; they do not provide the same customer protection regarding learning outcomes and utility.

Development of the e-learning quality standards

The Open eQuality Learning Standards (OeQLs) are based on best practices and research in distributed learning and learning technologies, developed through an international consultation process, and sponsored and endorsed by a number of national and international organizations. Project participants stipulated that the e-learning quality standards meet these criteria, that is, that they be:

- consumer oriented — developed with particular attention to return on investment in e-learning for learners;
- consensus based — developed through consultation with a balance of provider and consumer groups;
- comprehensive — inclusive of all elements of the learning system: outcomes and outputs, processes and practices, inputs and resources;
- recommended only — using suasion and market forces rather than legislation to ratchet up the quality of e-learning;
- futuristic — describing a preferred future rather than the present circumstances for design and delivery; and
- adaptable — best used for adult and post-secondary education and training, but adaptable to other levels of learning services.These are criteria that contribute to the unique nature of the OeQLs and the resulting quality assurance approach.

This work was an extension of the FuturEd research on Learnware quality (Barker, 1997, 1998), school effectiveness (ibid., 1998), uses of Information and communication Technologies (ICT) in international education at Canada's post-secondary institutions (ibid., 2001, 2003), return on investment in e-learning (Barker, 2005). The FuturEd approach to e-learning quality — the same process of environmental scanning, drafting of inclusive and comprehensive quality standards, consensus-based approval, and endorsement with subsequent consumers guide and quality assurance tools for informed choice — has been used in the context of national training standards (Barker, 1994), prior learning assessment standards (Barker, 1998, 2001), e-portfolio quality standards (Barker, 2004) and, most recently, learning objects (Barker, 2006).

Under FuturEd leadership, beginning in 1998 with funding from the Canadian federal government, e-learning experts in Canada began work on quality standards. To develop the consumer-based CanREGs, FuturEd undertook five steps. The first was to assemble an expert panel representing a balance of consumers and providers from seven national and international organizations, including Human Resources Development Canada (HRDC), SchoolNet (Industry Canada), and the Commonwealth of Learning. The second was an extensive literature search for both complete sets of guidelines and individual quality indicators for distance learning, education in general, and the use of learning technologies, resulting a background paper and draft standards for consultation purposes. The third step was a national consultation process, including workshops and an online workbook. The fourth step was refinement of the standards into the form of the Canadian Recommended E-learning Guidelines (CanREGs), based on consultation input, with experts from the field. The final step was the creation of a consumers guide to e-learning based on the CanREGs — providing potential purchasers with the questions to ask in order to identify quality e-learning and make informed choices. Comparing four different methods of e-learning quality assurance, Parker (2004) notes:

> In Canada, the responsibility for education rests at the provincial, not the national, level. Each province has its own quality assurance framework or approach to determining whether post-secondary programs are eligible for student funding or to receive public money. The degree to which a province might regulate or even provide subsidies to private or for-profit educational institutions varies widely. It is fitting, then, that the Canadian example of quality guidelines originates with a private corporation sponsored by community and government-funded agencies.

In 2002, FuturEd and the Canadian Association for Community Education (CACE) produced the CanREGs. In May 2004, the CanREGs became the Open eQuality Learning Standards and a Creative Commons "some rights reserved" copyright has been transferred to the European Institute for e-learning (EIfEL) and the Learning Innovations Forum d'Innovations d'Apprentissage (LIfIA), rendering the standards "open." Responsibility for maintaining the open source standards has been assumed by a joint EIfEL — LIfIA international committee. The joint eQuality Committee plans to meet annually and focus on maintaining the currency of the learning quality standards.

Underlying principles and conceptual basis

The project to create e-learning quality standards in Canada focused on the development of consumer-based quality guidelines that:

1. described either minimum acceptability and/or excellence in the application of learning technologies;
2. took the form of statements/principles of good practice or best practices, and included all elements of the learning system;
3. were developed by Canadian consumers to reflect Canadian values and concerns, but had potential applicability to the international environment;
4. were created through a consensus-based process involving actual consumers;
5. included a method of implementation that was neither cumbersome or costly;
6. incorporated the most current thinking on the effective use of learning technologies; and
7. contributed to increasing the effectiveness and efficiency of learning technologies and Canada's learning culture.

At that time of project inception, there were no commonly accepted standards of excellence in technology-based distance learning in Canada. There was, however, a great deal of useful advice in both literature and practice specific to quality assurance in education and training; applications of technology in education and training; quality assurance in Internet information sources and online practices in education and training; and excellence in distance education, distance learning, and distance delivery of education/training.

Quality assurance in education and training

In the context of products and services such as education/training, quality had been defined as having the characteristics of being well thought out, prepared with care, and implemented with responsibility; having a firm direction but flexible enough to cope with contextual variation; and being positively responsive to comment and criticism (Lucent Technologies, 1999).

An example of the definition of a quality educational experience, arrived at through stakeholder consensus, included the following elements: the quality of learning materials, the availability of materials, support for students through well-trained staff, a well-managed system, monitoring, and feedback mechanisms to improve the system (Barker, 1994). For the Canadian Labour Force Development Board, quality education was seen as education that produces an independent learner.

At that time, there was a growing interest in the delivery of high-quality education and training that met one or more types of standards, for example:

- standards for all elements of the learning system: inputs and resources, processes and practices, and outputs and outcomes (Barker, 1995);

- quality standards for education that is delivered transnationally, as set by the Global Alliance for Transnational Education (GATE, 1996);
- principles for good practice in undergraduate education, first published by the American Association for Higher Education in 1987;
- requirements for promoting lifelong learning (Candy, Crebert, & O'Leary, 1994);
- program quality for adult education programs (Office of Vocational and Adult Education, US Department of Education, July 1992);
- international education from the Centre for Quality Assurance in International Education;
- standards for student admissions from the American Association of Collegiate Registrars and Admissions Officers;
- assessment of students learning to use technology developed by the American Association for Higher Education;
- standards for instructional design by The International Board of Standards for Training, Performance and Instruction; and
- information literacy standards developed by the American Library Association.

The literature on quality assurance in education and training was vast, ranging over such topics as standards, national standards, quality assurance, accountability, effective schools, and so on. The focus had largely been on the provider's perspective; however, there were increasing demands from the public and from education/training consumers to be involved in describing and improving quality in learning systems.

Quality assurance in the uses of educational technologies

Quality in the use of educational technologies is viewed from many different perspectives: (1) what learning technologies are touted to achieve; (2) quality assurance in the appropriate uses of technologies; and (3) issues of quality and the Internet.

From the earliest uses of learning technologies there have been claims or hopes about what educational technologies could achieve. For example, according to the BC Ministry of Education, Skills and Training (BC MEST, 1996), technology was used to assist with the attainment of such educational goals as individualization; increasing proficiency at accessing, evaluating, and communicating information; increasing quantity and quality of students' thinking and writing; improving students' ability to solve complex problems; nurturing artistic expression; increasing global awareness; creating opportunities for students to do meaningful work; providing access to high-level and high-interest courses; making students feel comfortable with tools of the information age; and increasing the productivity and efficiency of schools. Similarly, Frayer and West (1997) identified the following ways in which instructional technology should support learning: enabling active engagement in construction of knowledge; making available real-world situations; providing representations in multiple modalities; drilling students on basic concepts to reach mastery; facilitating collaborative activity among students; seeing interconnections among concepts through hypertext; learning to use the tools of scholarship; and simulating laboratory work. From yet another perspective, NCREL (North Central Regional Educational Laboratory) developed a "technology effectiveness framework" which theorized that the intersection of two continua — with learning on one end of the axis and technology performance on the other — defines what a particular technology could achieve vis-à-vis student learning. One quality criterion, then, must relate to the use of appropriate technologies. These goals all contributed to a conceptualization of e-learning quality.

Technology has multiple uses in the context of education and learning, for example, information management (IT), learning management, and distance delivery. As well, technology has the capacity to deliver better forms of student assessment, that is, what the International Society for Technology in Education calls "authentic testing." To ensure the best uses of technology, the Open University in the UK differentiated between different media according to ease of use, availability, access, questions, contacts, experts, opportunity to question experts, integration, status, and synergy. The categories for comparison used were learners' needs, usage, effectiveness, perceived value, and comparative value. For the University of California, the four key characteristics of effective software are presentability, accountability, customizability, and extensibility. A second type of quality criteria, then, is the appropriate use of technology.

As the Internet was increasingly used in distance delivery of education/training, both for information retrieval (distributed learning) and for online delivery of courses and programs (distance learning), there was a need for quality criteria for both Internet sources and use of the Internet. The criteria for evaluating Internet information range from the simplistic to the highly complex. At the simplistic end of the scale, according to the University of

Wisconsin, the Ten C's for Evaluating Internet Resources are Content, Credibility, Critical thinking, Copyright, Citation, Continuity, Censorship, Connectivity, Comparability, and Context. At the complex end of the scale, Wilkinson and others at the University of Georgia developed a list including 11 criteria and 125 indicators in *Evaluating the Quality of Internet Information Sources: Consolidated Listing of Evaluation Criteria and Quality Indicators*, including but not limited to: site access and usability (18 indicators), resource identification (13 indicators), author identification (9 indicators), authority of author (5 indicators), information structure and design (19 indicators), relevance and scope of content (6 indicators), validity of content (9 indicators), accuracy and balance of content (8 indicators), navigation within the document (12 indicators), quality of the links (13 indicators), and aesthetic and affective aspects (13 indicators). They concluded that the indicators of (1) information quality and (2) site quality were ranked in importance by experienced Internet users. Somewhere in the middle, the Internet Public Library has a selection policy for quality information sources, and resources that are selected/approved by the IPL receive the IPL Ready Reference Seal. In summation, it is a particular concern of educators that the sources they use on the Internet are reliable, accurate, authoritative, current, fair, adequate, and efficient. These were all factored into the understanding of quality e-learning.

Further considered were quality education practices on the Internet. Specific to education and training offered on the Internet, a variety of tools and standards were created. At the broadest level, the American Association for Higher Education produced a *Bill of Rights and Responsibilities for the Electronic Community of Learners*, which set out the rights and responsibilities of individuals together with the rights and responsibilities of educational institutions. Teachers considering web-based instruction were strongly encouraged to consider choice of pedagogy over choice of available technology, particularly when some research suggested that the use of technology to enable instruction conveys no significant difference in student achievement (Reeves, 1997). All of these elements of e-learning quality were considered in the creation of the standards of excellence, which became the CanREGs and then the OeQLS.

Quality assurance in distance education and distance learning

Distance learning can be used for many purposes, for example, for formal education, continuing education, advanced professional education, and management/employee development. Advocates for distance learning claim that it makes learning and training more accessible, more convenient, more effective, and more cost-efficient for the learners and for the education provider.

The environment for distance learning is characterized as one in which remote students have special needs that include advising needs, access needs, communication needs, and administrative needs. In the traditional context — distance education delivered by traditional learning organizations for course/program credit — these needs should be met through appropriate institutional support structures. This means that providers of distance learning must help consumers to take greater responsibility for their own learning, become more active in asking questions and obtaining help, and be prepared to deal with technical difficulties in the two-way flow of information.

Research by Lucent Technologies indicates that the following three approaches are commonly advocated to develop independent and self-reliant distance learners:

1. the service model approach, which focuses on the providers' integration of quality into distance delivery and courseware through quality-assurance methods in courses and curricula, high quality support services, integration of the study of communication itself into the curriculum, and the Total Quality Management (TQM) model of consumer-oriented quality in methods and materials;
2. a stakeholder analysis model, which focuses on defining quality for distance education, that is, involving more than the learning providers in defining quality and setting benchmarks;
3. a quality improvement model, which involves ongoing evaluation such as qualitative assessment techniques to understand stakeholder values, and quantitative evaluation to provide indicators of quality and areas of concern.

In building a service approach to distance education programs, Fulkerth (1998) recommended that courses be flexible, nimble, and asynchronous; blend traditional education and applied technology skills; integrate institutional services and activities into the delivery environment (e.g., registration, payment, advising, tutorial assistance, library services); and incorporate personalized, high-touch access to services, instructors, and classmates. To assist in making informed decisions, Miller and Schlosberg (1997) created tools to help individuals determine if they were good candidates for online learning, and Porter (1997) set out a checklist for evaluating distance learning courses.

Finally, in some jurisdictions — the US and the Commonwealth — agencies had taken this one step further to develop standards of excellence for distance education. The Canadian Recommended E-learning Guidelines incorporate elements of:

- the Western Interstate Commission for Higher Education's (WICHE) principles of good practice for electronically offered academic degree and certificate programs;
- the American Council on Education, Center for Adult Learning and Educational Credentials' guiding principles for distance learning in a learning society; and
- the guidelines for remote delivery of courses, developed by the Commonwealth of Learning.

In conclusion, standards and best practices in education and training, uses of learning technologies, and distance education were incorporated into the development of the CanREGs. The next challenge was how to implement the standards, given that there was no desire or opportunity to create legislation and regulation.

Implementing e-learning quality assurance

As stated earlier, there was never an intention to create legislation or a body to regulate e-learning quality. In order to encourage good e-learning rather than punish bad e-learning, the quality-assurance approach adopted included three key elements: (1) the provision of e-learning quality standards created through consensus among providers and consumers of e-learning products and services; (2) the provision of a consumer's guide to e-learning, reflecting the quality standards, to help consumers compare products and services and, in demanding good e-learning, help to improve the overall quality; and (3) the provision of an objective, third-party quality mark that providers could use to indicate compliance with the quality standards and create a competitive advantage in the global marketplace.

The standards had been created and they could be used by developers of e-learning as a design or evaluation checklist. However, the jargon and conceptual density made them hard for learners or purchasers of e-learning to use; hence, an interactive tool was created and distributed widely by all the project participants. Regrettably, the use of the consumers guide to e-learning has not been tracked. Learners and purchasers were encouraged to either use the interactive guide when they had the time and if they could gather the necessary information from providers, or look for a quality mark as a short-hand method of assuring quality for themselves.

The final element, then, was the creation of a quality mark that would demonstrate compliance with these e-learning quality standards. Beginning in 2002, the eQcheck quality mark was made available to e-learning providers as a mark of objective, professional quality assurance. QualitE-Learning Assurance Inc (Canada) and QualitE-Learning Assurances Services (UK) — the "eQcheck group of companies" — operate worldwide through a system of brokers and partnerships. Using an online, e-portfolio approach, e-learning providers can earn the eQcheck quality mark by providing digital evidence of compliance with the CanREGs in Canada, and OeQLs internationally. Since 2002, other quality marks have been developed, marks that reflect different types of standards. For example, the American Association offers certification services for the quality of instructional design, largely from the perspective of professional trainers; the British Learning Association promotes a quality mark that is recognized largely in the United Kingdom; the European Foundation for E-learning Quality is developing a quality mark for the European Union. These quality-assurance initiatives are not mutually exclusive, and it is conceivable that e-learning products and services should acquire a number of quality marks if they can afford it. Primarily, consumers want the quality marks to provide a form of consumer confidence, as does the "Good Housekeeping Seal of Approval" on household goods, and a form of consumer protection, as does the Canadian Standards Association quality mark. Providers of e-learning want to achieve the industry excellence mark evidenced, for example, by the VQA quality mark on Canadian wine.

Companies in the eQcheck group do not provide e-learning products or services. It is, in fact, a legal requirement that a quality certifying body be independent and not be engaged in provision of such services. In 1998, FuturEd had identified the need to promote and support e-learning quality to provide consumer confidence and consumer protection in e-learning products and services. Government, national, and international bodies in Canada agreed with this and supported the creation of the CanREGs, and they subsequently endorsed the creation of the eQcheck quality mark and quality assurance approach.

The mission of the eQcheck companies is to support the e-learning industry by supporting both providers and consumers through assurance of high quality products and services. Producers use this process and certification mark in their marketing to indicate third-party quality assessment and OeQLs compliance. Consumers are urged to look for and insist upon the eQcheck as a measure of confidence and consumer protection. Governments and funding agencies are beginning to require it. The eQcheck quality mark is gaining currency worldwide because it transfers the cost of quality assurance from the consumer to the e-learning provider. This appeals to governments, industry, and large enterprises that buy a lot of e-learning products, and it appeals to the World Bank as it seeks to assure quality purchases for the loans it grants.

In addition, it differs from other e-learning quality assurance methods in that it is:

- transparent, that is, the industry-based standards are widely available;
- inexpensive, that is, producers are encouraged to undertake a self-assessment process, limiting the cost of earning the eQcheck mark to the cost of the audit process;
- iterative, that is, producers of e-learning can improve the quality of e-learning where weaknesses are identified.

The eQcheck is the only consumer-based e-learning quality-assurance system in the world. It dovetails easily with other methods, ensuring that e-learning meets technical quality standards for interoperability.

The development and implementation of this quality-assurance mechanism has not been without significant challenges. Is the e-learning enterprise ready for consumer empowerment? Dr. Abrioux, when he was president of Athabasca University, thought so. He asserted that students were customers, and that customer satisfaction was his first priority. He formally encouraged other universities to adopt the approach of the consumer's guide based on the OeQLs.

A number of products and services have earned the eQcheck quality certification mark. In the process, this Canadian case study demonstrates a number of valuable lessons about how complex and confusing the e-learning enterprise is, even to professional educators. The major challenge to implementation, however, has been the processes of quality assurance in public education worldwide. The predominant quality-assurance mechanisms include peer review of programs and, in some cases, state and professional regulation of curricula. This leads to the quality paradox — that is, the fact that providers of any product or service must assure quality but they can't provide quality assurance. Quality assurance must be:

- objective (incorporating both provider and user views)
- professional (conducted by quality assessors)
- credible (when compared to standards of excellence)
- reputable (using processes and standards recognized by others)
- iterative (process-oriented)
- continuous (ongoing and built in to the organization's funding and planning strategies)

Quality-assurance claims that come from education providers alone are subjective and questionable at best. Therefore, objective, professional quality assurance through a quality mark and objective professional quality certification provides for a win-win-win scenario. Students win with credible, consumer-oriented information to help them make informed choices. E-learning providers win with objective evidence to enhance their reputation and create competitive advantage, the consumer quality mark. The e-learning enterprise wins with substantial effort directed at quality, return on investment and, ultimately, sustainability. These are all issues that support the implementation of informed choice and consumer pressure for assured quality. In a world where there are increasing numbers of dedicated online learning providers, it is essential to provide consumer protection and consumer confidence in both online and on-site learning.

Table 1 outlines the main categories and elements of the approach.

Table 1. Outline of main categories and elements

E-learning Elements	**Quality Criteria**	**Sample Quality Requirements**
Outcomes and Outputs	1. Skills and knowledge acquired 2. Learning skills acquired 3. Credits and credentials awarded 4. Return on investment	3. Credits and credentials are: 3.1 Recognized by relevant professional bodies 3.2 Recognized by other education institutions 3.3 Of the same value as on-site delivery 3.4 Transferable within and between programs, institutions, and countries
Processes and Practices	1. Management of students 2. Delivery and management of learning 3. Appropriately used technologies	2. Delivery and management of learning 2.2.1 Approaches to learning • Foster active learning

	4. Communications	• Build on learner's strengths • Support interaction • Increase learner control • Include assistive devices for persons with disabilities
Inputs and Resources	1. Intended learning outcomes 2. Curriculum content 3. Teaching/learning materials 4. Product/service information 5. Appropriate learning technologies 6. Sound technical design 7. Personnel 8. Learning resources 9. Complete learning package 10. Comprehensive course package 11. Routine review and evaluation 12. Program plans and budget 13. Advertising and admissions information	3.1 Intended learning outcomes are: 3.1.1 clearly stated 3.1.2 relevant 3.1.3 observable / demonstrable 3.1.4 measurable 3.1.5 achievable and realistic 3.1.6 appropriate to the degree 3.1.7. consistent with provider mandate

The entire set of quality standards is available online at www.FuturEd.com. In brief, the standards begin with what is most important to consumers: assurance that they will learn content skills and knowledge that are relevant and recognized, together with lifelong learning skills that are transferable and applicable. When consumers are assured their investment of time and finances will be rewarded with recognized competencies and credits (quality outcomes), they then concern themselves with the details of student services and delivery: teaching, learning, assessment, and support (quality processes and practices). When they are assured that teaching and learning are appropriate and effective, they finally concern themselves with the nature of the organization standing behind the learning service: the quality of staff, budgets, and plans (quality inputs).

Conclusion

This Canadian initiative to support e-learning quality was grounded in conventional best practices in distance learning, learner-centred education and training, and global use of learning technologies. The resulting e-learning quality standards are consumer-oriented, consensus-based, comprehensive, futuristic, adaptable, and flexible. At this time, the eQcheck quality mark, based on the quality standards, is the only internationally recognized e-learning quality mark, and consumers are beginning to look for it to provide consumer confidence and consumer protection. That being said, there must be a constant effort to update the standards, as learning technologies change and new approaches to the management of learning are developed. Efforts are under way to implement e-portfolio systems for e-learning quality assurance, systems that are based on quality standards and that require digital evidence to support quality claims. This is but one approach to quality assurance in e-learning, a natural partner to technical and interoperability standards.

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Developing an Information Commitment Survey for assessing students' web information searching strategies and evaluative standards for web materials

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ABSTRACT

The idea of "information commitments" refers to both learners' online searching strategies and the evaluative standards that students use to assess the accuracy and usefulness of information in web-based learning environments. Based upon the results of a pioneering and qualitative study on information commitments, this study aimed to develop an Information Commitments Survey (ICS) for assessing the information commitments of 1220 college and graduate students. A series of multivariate multiple regression analyses were also conducted to evaluate the ability of students' evaluative standards as well as their Internet experiences for predicting their online searching strategies. The results showed that the ICS was deemed to be sufficiently reliable for assessing students' information commitments. Gender differences regarding the participants' usage of certain searching strategies were found in this study. Moreover, the students' grade level as well as their Internet experiences played a significant role in their information commitments. The multivariate multiple regression analyses revealed that both the students' use of sophisticated evaluative standards and their Internet experiences significantly predicted the use of sophisticated searching strategies, while their use of less advanced evaluative standards significantly predicted the use of less advanced searching strategies.

Keywords

Information commitments; Information searching strategy; Evaluative standards of web information; Web-based learning

Introduction

During the last decade, web-based instruction has been highly advocated (e.g., Black & McClintock, 1996; Chou & Tsai, 2002; Jonassen et al., 1999) and implemented at all levels of education. Undoubtedly, searching and using web information can greatly enrich students' learning processes and outcomes in web-based learning environments. As a result, learners' information searching in web-based learning environments has been highlighted, and a considerable amount of research has been conducted to explore the nature of learners' information searching on the Internet (e.g., Bilal, 2000, 2001; Hess, 1999; Lazonder et al., 2000; Rouet, 2003; Whitmire, 2003, 2004).

One of the important topics regarding the nature of learners' online searching is which factors influence online searching. In relevant studies, several factors have been identified (e.g., Bilal, 2000, 2001; Wang et al., 2000). Searching strategy is one of them (Pharo & Jarvelin, 2004).

In the process of information searching, the searching strategies learners employ may guide their searching behavior on the Internet. However, when searching information in web-based learning environments, students with expert Internet experience demonstrate better searching strategies than those with novice Internet experience (Tsai & Tsai, 2003). The different online searching strategies used by expert and novice users may lead to different search results, which can be viewed as an important indicator of learners' performance and outcomes derived from web-based learning environments.

Learners may use a variety of searching strategies on the Internet. These online searching strategies may be considered as their approaches to learning in web-based learning environments. Traditionally, educators have proposed the idea of "learning approaches" (or "approaches to learning") to refer to the ways students complete their academic tasks. They have also distinguished students' learning strategies as either deep or surface approaches (Biggs, 1987, 1994; Marton, 1983). The deep approach is characterized by an intention to seek the meaning of the material being studied by elaborating on and transforming it, while the surface approach is characterized by an intention to reproduce the material being studied by using routine procedures (Dart et al., 2000). Similar to the way students use different learning approaches in a conventional educational environment, learners may also use different learning approaches in web-based learning environments. For example, they may have purposeful thinking, employ an "elaboration" searching strategy to integrate web information from several websites, and try to elaborate and transform web material being studied. Conversely, they may limit their results by reproducing web material employing the "match" strategy, by which they fulfill their searching purposes through finding only a few websites that contain most fruitful and relevant material being studied. This distinction has been proposed in Tsai's (2004) study. Therefore, the searching strategies learners employ to seek web information can be viewed as their learning approaches in processing web-based academic tasks (Wu & Tsai, 2005a). Moreover, it is plausible that learners using the "elaboration" searching strategy can be viewed as employing the deep approach to learning in web-based academic tasks, while learners using the "match" searching strategy can be viewed as employing the surface approach to learning in web-based academic tasks.

In addition, learners' ability to locate websites greatly influences their search results in web-based learning environments (e.g., Lazonder, 1999). Locating an appropriate website is the first phase in the process of online information searching. In relevant studies, it was found that novice and experienced users had different abilities in their locating websites when they search information on the Internet (e.g., Lazonder et al., 2000). It was indicated that experienced learners may have better ability in assessing and judging the websites and the information they had searched, so they can outperform novice users in locating websites. That is, experienced learners may utilize better standards to help them evaluative the websites or information they have searched, and these evaluative standards can also viewed important indicators of their searching results.

As previously mentioned, learners' online searching strategies and their evaluative standards for web materials are two of the important indicators for their searching processes in web-based learning environments. To address these two important issues, Tsai (2004) has defined the idea of "information commitments" for web learners in web-based learning environments. The information commitments proposed by Tsai involve the searching strategies learners employ on the Internet and a set of evaluative standards learners use to assess the accuracy and usefulness of information in web-based learning environments. According to Tsai, learners may employ various evaluative standards for assessing the accuracy and usefulness of web materials in web-based learning environments, and it is plausible to assume that these evaluative standards would lead to different types of information searching strategies on the Internet. In addition, educators have proposed that students' epistemological commitments will guide their conceptual development and knowledge growth. Similarly, students' information commitments are likely guiding their processes and outcomes of knowledge construction in web-based learning environments.

Tsai (2004) also proposed the following theoretical framework for describing web users' information commitments in web-based learning, including the three aspects:

1. *Searching strategy*: The searching strategies that web users employ to seek web information. The possible orientations are "Elaboration" versus "Match." The "Elaboration" indicates that learners may have purposeful thinking when navigating in the web, and try to integrate web information from several websites to find the best fit for their purpose, while the "Match" indicates that learners may be eager to match their searching purposes by finding only a few websites that contain most fruitful and relevant information. Tsai (2004) suggests that these two searching strategies are likely opposite.
2. *Standards for accuracy*: The standards that learners use to verify the accuracy of web information. The possible orientations are "Multiple sources" versus "Authority." Some web users usually use "Multiple sources," such as other websites, prior knowledge, peers, or other printed materials, to examine the accuracy of web information, while others use the "Authority" of the website as a major indicator of accuracy. According to Tsai, these two orientations are likely opposite.
3. *Standards for usefulness*: The standards that learners use to evaluate the usefulness of web information. The possible orientations are "Content" versus "Technical" (functional). "Content" refers to the relevance of web content, while "Technical" refers to the functional and technical issues of the web (e.g., the ease of retrieval of information, the ease of search) as major indicators of usefulness. The orientation toward evaluating the usefulness of web information by "Content" is likely opposite the orientation toward evaluating the usefulness by "Technical" (Tsai, 2004).

Among these three aspects of information commitments, the first one is the information searching strategy used by web users and the others are their evaluative standards for web materials. Tsai (2004) also concluded that the three information commitments, categorized as "Elaboration", "Multiple sources" and "Content", which were expressed by experts, were advanced information commitments, while the others were viewed as less sophisticated.

Clearly, an exploration of learners' information commitments addresses the two aforementioned issues: learners' online search strategies and their evaluative standards for web materials, and the development of a reliable instrument for assessing students' information commitments should be of much importance. To this end, there were two stages for the development of the instrument for assessing learners' information commitments: the exploratory stage and the confirmatory stage. In the exploratory stage, on the basis of Tsai's (2004) qualitative study, the Information Commitments Survey (ICS) was developed, and some exploratory analyses were also conducted; in the confirmatory stage, a series of structural equation modeling (SEM) analyses with LISREL were conducted to reconfirm the reliability and validity of ICS. This study reported the results of the exploratory stage (An earlier version of this study was presented at 2005 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education, Vancouver, Canada.), while the results of the confirmatory stage were presented in Wu and Tsai (2005b). In other words, this study aimed to develop the Information Commitments Survey (ICS) for assessing students' information commitments. With this instrument, a group of college and graduate students' information commitments were explored in this study.

Gender differences in Internet-related issues are always highlighted by researchers (e.g., Colley & Comber, 2003; Kadijevich, 2000). As an initial attempt, this study also investigated whether gender differences existed on learners' information commitments. Also, the role Internet experiences as well as grade levels played in college and graduate students' information commitments were also examined. In addition, how different factors influence learners' information seeking behavior and strategies on the Internet has also received lots of attention from researchers (e.g., Bilal, 2000, 2001; Pharo & Jarvelin, 2004). However, still not many studies have been conducted to investigate the factors affect learners' searching strategies (e.g., Tsai & Tsai, 2003). Therefore, through multivariate multiple regression analyses, the current study also examined the ability of the orientations of learners' evaluative standards for web materials as well as their Internet experiences for predicting their online searching strategies.

In sum, this study investigated the following questions:
1. Is the ICS developed in this study sufficiently reliable for assessing students' information commitments?
2. What are the university students' information commitments?
3. Is there any gender difference in university students' Internet attitudes? How?
4. What is the role of university students' Internet experiences in their information commitments?
5. What is the role of university students' grade level in their information commitments?
6. How do learners' evaluative standards for web materials as well as their Internet experiences predict their online searching strategies?

Methodology

Sample

Based upon the results of the previous qualitative study (i.e., Tsai, 2004), this study aimed to develop an instrument for assessing students' information commitments. The sample in Tsai (2004) involved university students. Therefore, the subjects of this study and those of Wu and Tsai (2005b) are also university students. However, the subjects of this study are not the same as those of Wu and Tsai (2005b).

The subjects of this study were 1220 volunteers with different Internet experiences (including 799 males and 421 females) in Taiwan. They were either undergraduate or graduate students (including 833 college students and 387 graduate students), coming from four famous national universities in north Taiwan. Most of them majored in science or engineering, so relatively more males were in the sample. This large sample may have represented many college and graduate students in various science and technology-based universities in Taiwan.

Questionnaire for assessing students' information commitments

To assess students' information commitments in web-based learning environments, a questionnaire, called the Information Commitments Survey (ICS), was administered in this study. This questionnaire was developed on the basis of the theoretical framework proposed by Tsai (2004). The interview responses in Tsai (2004) also provided a foundation for the development of the items in this questionnaire. After the initial construction of the ICS, an expert in the field of web-based instruction commented on it for its face validity, and seven university students were chosen to clarify the wording of each statement.

In this study, Likert-type rating scales were used to gather the data about students' information commitments. There has been a continuing and fierce debate on the use of Likert-type rating scales (Knapp, 1990). Although the response categories in Likert scales have a rank order and should be viewed as ordinal-level measurement, it has become common practice to assume that Likert-type categories constitute interval-level measurement as well as the intervals between values are equal (Jamieson, 2004). On the issue of the usage of Likert-type rating scales, two opposite positions have been held by researchers. Some researchers have argued that the aforementioned use of Likert scales may led to error in interpreting data and the relations inferred from data, while others have proposed that the danger is probably not as grave as it has made out to be and the results we get from using summated scales and assuming equal intervals are quite satisfactory (e.g., Kerlinger & Lee, 2000). For the pragmatic considerations, the perspective adopted in this paper is the same as the latter. However, caution must be used when interpreting the results.

The ICS included of six scales (initially a total of 38 items), which were presented with bipolar strongly agree/ strongly disagree statements in a six-point Likert scale (i.e., strongly agree, agree, somewhat agree, somewhat disagree, disagree and strongly disagree). The use of six-point Likert scale was to avoid students' selection of totally neutral position for many items. A detailed description of the six scales and sample items from each scale were presented below:

1. *Elaboration as searching strategy scale (Elaboration)*: measuring the extent to which students will have purposeful (metacognitive) thinking or integrate web information from several websites to find the best fit that fulfilled their purpose.
2. *Match as searching strategy scale (Match)*: investigating the extent to which students will be eager to find only a few websites that contain the most fruitful and relevant information. Their strategy is oriented to match searching purposes.
3. *Multiple sources as correctness scale (Multiple sources)*: measuring the extent to which students will validate the correctness of unknown information on web by relating to other websites, prior knowledge, peers, or other printed materials.
4. *Authority as correctness scale (Authority)*: assessing the extent to which students will examine the accuracy of unknown information in web-based learning environments by the authority of the websites or sources.
5. *Content as usefulness scale (Content)*: measuring the extent to which students will assess the usefulness of the information viewed in web-based learning environments by the relevancy of its content.
6. *Technical issues as usefulness scale (Technical)*: assessing the extent to which students will judge the usefulness of the information viewed in web-based learning environments by the ease of retrieval, the ease of searching or the ease of obtaining information. Therefore, their standard for evaluating web information is more related to some technical issues.

In this study, the questionnaire was presented in digital format, and the participants were asked to fill out their response on the web. Moreover, the questionnaire was presented in Chinese when undertaking this study, and the questionnaire items, shown in this paper, were translated by the authors.

Results

Factor analysis

In this study, exploratory factor analysis was conducted to clarify the structure of the information commitments in web-based learning environments. The principle component analysis was used as the extraction method, and the rotation method was varimax with Kasier normalization. An item was retained only when it loaded greater than 0.50 on the relevant factor and less than 0.50 on the non-relevant factor.

The factor analysis revealed that the subjects' responses on the questionnaire were grouped into six factors, which were: "Elaboration", "Match", "Multiple sources", "Authority", "Content", and "Technical". The six factors were exactly the same as those initially proposed by Tsai (2004). All the eigenvalues of the six factors were larger than one, and these factors accounted for 65.30% of variance. There were respectively 5, 3, 3, 4, 5, and 4 items in these six scales. The items and responding scales are shown in the Appendix, and the factor loadings for the retained items are presented in Table 1 (To match the theoretical framework of ICS, the factors are not reported in the order of their extractions.). The reliability (alpha) coefficients for these scales respectively were 0.84, 0.74, 0.72, 0.82, 0.88, and 0.76, and the overall alpha was 0.80. Therefore these scales were deemed to be sufficiently reliable for assessing students' information commitments in web-based learning environments.

Table 1: Rotated factor loadings and Cronbach's α values for the six factors (scales) of ICS (n=1220)

Item	Factor 1: Elaboration	Factor 2: Match	Factor 3: Multiple	Factor 4: Authority	Factor 5: Content	Factor 6: Technical

			sources			
Factor 1: *Elaboration* α=0.84						
Elaboration 1	0.76					
Elaboration 2	0.68					
Elaboration 3	0.76					
Elaboration 4	0.72					
Elaboration 5	0.72					
Factor 2: *Match* α=0.74						
Match 1		0.81				
Match 2		0.80				
Match 3		0.74				
Factor 3: *Multiple sources* α=0.72						
Multi. Sour. 1			0.77			
Multi. Sour. 2			0.86			
Multi. Sour. 3			0.63			
Factor 4: *Authority* α=0.82						
Authority 1				0.80		
Authority 2				0.79		
Authority 3				0.79		
Authority 4				0.73		
Factor 5: *Content* α=0.88						
Content 1					0.75	
Content 2					0.81	
Content 3					0.83	
Content 4					0.77	
Content 5					0.71	
Factor 6: *Technical* α=0.76						
Technical 1						0.64
Technical 2						0.82
Technical 3						0.79
Technical 4						0.72
Eigen-value	3.1	1.33	1.13	2.10	6.32	1.68
% of variance	12.96	5.53	4.70	8.77	26.33	7.01

Overall α = 0.80, total variance explained is 65.30%

Students' scores on the scales

Table 2 shows students' average item scores and standard deviations on the six scales of the ICS. According to Table 2, students scored highest on the "Content" (an average of 5.11 per item), followed by "Elaboration" (an average of 4.90 per item), "Authority" (an average of 4.66 per item), "Multiple sources" (an average of 4.49 per item), "Technical" (an average of 4.03 per item), and "Match" (an average of 2.94 per item). The results indicated that the students, on average, did not agree that they often used the "match" searching strategy.

Table 2: Students' scores on the scales of ICS (n=1220)

Scale	# of items	Item mean	SD
Elaboration	5	4.90	0.65
Match	3	2.94	1.02
Multiple sources	3	4.49	0.76
Authority	4	4.66	0.74
Content	5	5.11	0.58
Technical	4	4.03	0.88

Gender differences on information commitments

Table 3 shows that the male students and the female students in this study only had significant differences in terms of their scores on the "Match" scale ($p<0.01$). It indicated that, compared with the female students, the male students in this study were more oriented to use the "match" searching strategy when seeking information on the web.

Table 3: Gender comparisons on the scales of ICS

Scale	Gender	Mean	S.D.	t
Elaboration	Male	4.89	0.66	-0.62
	Female	4.91	0.62	
Match	Male	3.00	1.03	2.99**
	Female	2.82	0.98	
Multiple sources	Male	4.50	0.78	0.96
	Female	4.46	0.73	
Authority	Male	4.67	0.76	0.68
	Female	4.64	0.69	
Content	Male	5.13	0.60	1.27
	Female	5.08	0.55	
Technical	Male	4.04	0.89	0.50
	Female	4.01	0.85	

** $p < .01$

The role of Internet experiences in information commitments

In this study, the amount of the participant's online hours on average per week was regarded as his/her Internet experience. According to the students' online hours on average per week, they were divided into five groups of different Internet experiences: less than 14 hours (n=241), 14-21 hours (n=273), 21-28 hours (n=179), 28-35 hours (n=221), and finally more than 35 hours (n=306). An analysis of the role of Internet experiences in the scales of information commitments is presented in Table 4.

Table 4: Students' responses on the ICS among groups of different Internet experiences

Online hours per week	Elaboration (mean, S.D.)	Match (mean, S.D.)	Multiple sources (mean, S.D.)	Authority (mean, S.D.)	Content (mean, S.D.)	Technical (mean, S.D.)
(1) Less than 14 hours (n=241)	4.79 (0.66)	3.09 (0.96)	4.40 (0.73)	4.58 (0.72)	5.00 (0.60)	3.96 (0.88)
(2) 14-21 hours (n=273)	4.83 (0.61)	2.85 (0.97)	4.45 (0.79)	4.66 (0.73)	5.11 (0.53)	3.96 (0.85)
(3) 21-28 hours (n=179)	4.94 (0.61)	2.87 (1.00)	4.54 (0.71)	4.68 (0.67)	5.15 (0.57)	4.07 (0.85)
(4) 28-35 hours (n=221)	4.92 (0.66)	3.06 (1.07)	4.56 (0.74)	4.69 (0.76)	5.14 (0.60)	4.11 (0.87)
(5) more than 35 hours (n=306)	4.99 (0.67)	2.84 (1.05)	4.50 (0.80)	4.70 (0.77)	5.16 (0.61)	4.07 (0.92)
F (ANOVA)	4.27**	3.54**	1.65	1.11	3.24*	1.61
Scheffe Test	(6)>(2)				(6)<(2)	

* $p < .05$, ** $p < .01$

As shown in Table 4, the ANOVA tests revealed that the students' Internet experience played a role in their use of the "elaboration", and "match" searching strategies, and the use of the evaluative standard, "Content". A series of Scheffe tests (post hoc tests) further indicated that the students having more than 35 hours of using the Internet on average per week were more prone to utilize the "Elaboration" searching strategy and the evaluative standard, "Content ". It implied that those who had more time of using the Internet, in general, tended to be more oriented to utilize sophisticated searching strategy (i.e., "Elaboration") and certain advanced evaluative standards for assessing the usefulness of the materials in web-based learning environments (i.e., "Content").

The role of grade level in information commitments

The subjects of this study were also divided into three groups: the freshmen and sophomore group (n=291), the junior and senior group (n=542), and the graduate student group (n=387). Then, a series of ANOVA test analyses were conducted in this study, and the results are summarized in Table 5

Table 5: Students' responses on the ICS among different grade levels

Grade	Elaboration	Match	Multiple sources	Authority	Content	Technical
	(mean, S.D.)	(mean, S.D.)	(mean, S.D.)	(mean, S.D.)	(mean, S.D.)	(mean, S.D.)
(1) Freshmen & Sophomore	4.84(0.69)	2.98(0.99)	4.42(0.87)	4.62(0.77)	5.10(0.65)	3.94(0.87)
(2) Junior & Senior	4.89(0.62)	2.94(1.05)	4.45(0.73)	4.69(0.69)	5.09(0.55)	4.04(0.87)
(3) Graduate	4.95(0.64)	2.90(0.99)	4.59(0.70)	4.65(0.77)	5.14(0.58)	4.08(0.89)
F(ANOVA)	2.35	0.51	5.19**	0.75	0.95	2.30
Scheffe Test			(3)>(1) (3)>(2)			

** $p < .01$

As revealed in Table 5, the ANOVA tests showed that the participants' grade level played a role only in their scores on the "Multiple sources" scale. Moreover, a series of Scheffe tests (post hoc tests) further indicated that the students in the graduate group tended to score statistically higher than those in the other two groups did on the "Multiple sources" scale. However, the students of the junior and senior group did not score significantly higher than those in the freshmen and sophomore group did on this scale. In sum, the graduate students may be more oriented to utilize multiple sources to assess the correctness of the materials in web-based learning environments than the college students.

Predicting students' information searching strategies

One of the major purposes of this study was to examine the predictive power of using learners' evaluative standards for web materials to predict their online searching strategies. To this end, multivariate multiple regression analyses, using Ordinary Least Square method (OLS), were conducted as the major statistical method. The participants' responses on the four ICS scales related to students' evaluative standards for web materials (i.e., "Multiple sources", "Authority", "Content", and "Technical") were perceived as the predictors. In addition, students may better develop their searching strategies if they have more opportunities to search information on the web. Therefore, the participants' Internet experience (i.e., their online hours per week) was also included as a predictor for their usage of two different searching strategies (i.e., "Elaboration" and "Match") in this study.

Table 6: Multivariate multiple regression estimates for predicting students' searching strategies (n=1220)

	Elaboration		Match	
Predictors	β	Std. error	β	Std. error
Multiple sources	0.29^{**}	0.02	-0.11^{*}	0.04
Authority	0.03	0.02	0.17^{**}	0.04
Content	0.44^{**}	0.03	-0.42^{**}	0.05
Technical	0.01	0.02	0.34^{**}	0.03
Online hours per week	0.02^{*}	0.01	-0.03	0.02
R-square	0.39		0.14	
Breusch-Pagan test of independence (x^2)	46.62^{**}			

$^{*}p < .05$; $^{**}p < .01$

Table 6 showed that "Content" (β=0.44, p<.01), "Multiple sources" (β=0.29, p<.01), and "students' online hours per week" (β=0.02, p<.05) could significantly and positively predict "Elaboration", and they explained 39% of students' usage of the "elaboration" searching strategy. In addition, "Technical" (β=0.34, p<.01) and "Authority" (β=0.17, p<.01) were both significantly positive predictors for "Match", while "Multiple sources" (β=-0.11, p<.05) and "Content" (β=-0.42, p<.01) were significant but negative predictors for "Match". Totally, these four factors accounted for 14% variance. In addition, the multivariate multiple regression analyses also provide a way to test whether the two equations are related. By the Breusch-Pagan test of independence, it was found that

“Elaboration” and “Match” were significantly and negatively correlated (r=-0.2, $p<.01$). Therefore, it was appropriate to estimate these two equations jointly, rather than independently.

In sum, the results in Table 6 indicated that learners, who were more oriented to assess the accuracy and usefulness of web materials by multiple sources and their content, and those who searched information on the Internet frequently, were more likely to employ the “elaboration” searching strategy in web-based learning environments. On the other hand, learners, who were more inclined to evaluate the accuracy and usefulness of web information by its authority and technical issues, and those who were less inclined to judge the accuracy and usefulness of web information by multiple sources and its content, were more possible to use the “match” searching strategy. In addition, the significantly negative correlation between “Match” and “Elaboration” also implied that they were likely opposite searching strategies.

Discussion

In this study, an instrument for assessing students’ information commitments in web-based learning environments (i.e., the Information Commitments Survey; ICS) was developed. The results showed that the ICS developed in this study was deemed to be sufficiently reliable for assessing students’ information commitments in web-based learning environments. Wu and Tsai (2005b), by another sample, have also conducted confirmatory factor analysis to examine ICS, and shown adequate reliability for the instrument. In this study, some gender differences and grade-level differences on information commitments were also found. Moreover, through multivariate multiple regression analyses, some predictors for students’ searching strategies on the Internet were also revealed. These results are discussed below.

Gender differences in Internet-related issues have always been highlighted by researchers (e.g., Colley & Comber, 2003; Kadijevich, 2000). In this study, gender difference was also found in the students’ use of the information commitment categorized as “Match”. The male students were significantly more oriented to use the “match” searching strategy than did the females. “Match” is a less sophisticated searching strategy. The finding is worthy of noting, because it contradicted to most studies regarding the relationships between technology and gender, suggesting that the males almost outperform the females in computer-related issues (e.g., Durndell & Haag, 2002; Tsai *et al*., 2001). Thus, further investigations should be conducted to explore the gender differences in searching strategies and behaviors.

In their previous study, Metzger *et al*. (2003) have revealed that many college students may depend on the Internet to provide accurate information without ensuring the accuracy of the information they obtain. The college students may not verify the information they have searched, implying that they tend to evaluate the correctness by its authority. In this study, the graduate students were more oriented to utilize multiple sources to judge the correctness of the materials in web-based learning environments than college students did. It may be likely due to their course work and academic tasks to be completed and professional training. However, further studies are needed to confirm this assertion. The finding above is also consistent with the perspective proposed by Metzger *et al.* (2003) that college students’ web information verification behaviors should be more emphasized. That is, the importance of assessing the accuracy of web materials should be highlighted for students in web-based learning environments.

Tsai (2004) has proposed that “Elaboration” and “Match” were likely two opposite searching strategies. The results derived from the multivariate multiple regression analyses demonstrated a significantly negative correlation between “Elaboration” and “Match”, implying that they were possibly opposite searching strategies. Therefore, the results above were consistent with Tsai’s (2004) perspective.

The results in this study seem to provide some empirical evidence to support an aforementioned perspective that the searching strategies learners employ on the Internet may be viewed as their learning approaches in web-based learning environments. In this study, it was revealed that “Elaboration” and “Match” were possibly opposite searching strategies. In addition, Tsai (2004) has proposed that “Elaboration” can be viewed as a sophisticated searching strategy, while “Match” should be viewed as a less sophisticated searching strategy. As the idea of learning approaches in traditional educational context, the web searching strategies, in which learners employ to seek web information, can be viewed as their learning approaches in web-based academic task (a specific educational context). That is, learners’ “elaboration” searching strategy can be viewed as their usage of the *deep approach* to learning in web-based academic tasks, while students’ “match” searching strategy can be viewed as their use of the *surface approach* to learning on the web. However, further studies are needed for examining this perspective.

In Tsai's (2004) perspectives, the three information commitments, categorized as "multiple sources", "Content" and "Elaboration", which were expressed by experts, were advanced information commitments, while the others were less sophisticated. The results in this study also provided some empirical evidence for his perspectives. As previously mentioned, this study has revealed that "Elaboration" and "Match" were two opposite searching strategies, and "Elaboration" can be viewed as a sophisticated searching strategy, while "Match" should be viewed as a less advanced one. This study also found that learners, who were more oriented to assess the accuracy and usefulness of web information by multiple sources and content, and those who searched information on the web more frequently, tended to employ the "elaboration" searching strategy in web-based learning environments. On the other hand, learners, who were more inclined to evaluate the accuracy and usefulness of web information by its authority and technical issues, and those who were less inclined to judge its accuracy and usefulness by multiple sources and content, were more inclined to use the "match" searching strategy. In other words, when searching in web-based learning environments, experts commonly tend to express the following three information commitments: "Multiple sources", "Content", and "Elaboration", while novices are more oriented to have the other three information commitments: "Authority", "Technical", and "Match".

In addition, similar to the findings about the significant relationships between students' epistemologies and their approaches to learning (e.g., Edmondson & Novak, 1993; Tsai, 1998, 1999), it was found in this study that learners' evaluative standards for web materials, shaping some epistemological standards for web information, can be viewed as important indicators for predicting their searching strategies in web-based learning environments. Therefore, further empirical studies are suggested to carefully examine the interplay between learners' evaluative standards for web materials and their online searching strategies. The studies completed by Whitmire (2003, 2004) and Hofer (2004), Tsai and Chunag (2005) can be viewed as some initial attempts for this research issue. Recently, Braten and Stromso (2006) have also reported that student teachers' Internet-based learning activities (including Internet-search activities and Internet-communication activities) could be predicted by their epistemological beliefs, interest, and gender. In this study, we also found that learners' evaluative standards for web materials, shaping some epistemological standards for web information, can be viewed as important indicators for predicting their online searching strategies. Tsai (2004) also asserted that learners' information commitments should be related to their epistemological beliefs. As reported in Braten and Stromso (2006) that learners' epistemological beliefs is an important predictor for their Internet-based learning activities, their information commitments may also constitute an important predictor for their Internet-based learning activities. However, empirical research is needed to confirm this perspective. In addition, further studies can be also conducted to investigate the relationships between learners' epistemological beliefs and their information commitments.

Furthermore, this study showed that students' frequency of using the Internet per week was also a significant predictor for their use of the "elaboration" searching strategy. That is, the more time learners spend in searching information on the Internet, the more learners may be oriented to develop a sophisticated searching strategy (i.e., "Elaboration"). To help learners develop a more advanced searching strategy, educators should try to provide them with more opportunities to search information in web-based learning environments. Thus, they are expected to attain better performances and learning outcomes in web-based learning.

Kuhn and Weinstock (2002) described the progression of learners' epistemological beliefs in the sequence of the following levels: realist, absolutist, multiplist, and evaluativist. In their viewpoints, learners, who have developed their epistemological beliefs in the "evaluativist" level, will examine and compare claims according to the merits of argument and evidence. In this study, the graduate students tended to express a more significant tendency to use multiple sources to evaluate the accuracy of the information they searched. In other words, the graduate students in this study might have developed their epistemological beliefs in the "evaluativist" level, in which they judged the correctness of the web information they had searched by assessing or contrasting multiple sources of information. Also, Perry (1970) has suggested a structural, systematic progression of an individual's epistemological beliefs in the following stages: dualism, multiplicity, relativism, and commitments within relativism. In this study, the graduate students in the perspective of using multiple sources in verifying web information seemed to hold more advanced information commitments than college students did. The information commitments shown by web users might be similar to Perry's (1970) perspectives on epistemological beliefs, and could be conceptualized as a developmental process that proceeds in a patterned, stage sequence. However, it requires more follow-up research, especially a series of longitudinal studies, conducted to trace a group of students' progression in their information commitments across academic years, and then to examine whether their of information commitments can be illustrated as a developmental sequence in a patterned, developmental sequence.

Hofer (2004) has argued that student use of the Internet as a medium for learning involves a host of epistemological judgments that deserve more attention, and students' metacognitive aspects of epistemological understanding during online searching should be trained to enhance their ability to think critically about seeking and evaluating. Tsai (2001b) also suggested an active and complicated interplay among epistemological beliefs, critical thinking and metacognitive processes in learning activities. Therefore, the interrelationships among learners' information commitments, metacognitive engagement and their learning outcomes in web-base learning environments, and how these commitments guide their metacognitive awareness, usage of web information and learning should also be investigated. The current study, clearly, is an initial attempt for these issues.

Study limitation

As aforementioned, this study is one of the initial attempts to explore university students' information commitments, and the findings in this study may be helpful for educators to get some insights into university students' information commitments. However, it should be noticed that the findings in this study were obtained through the use of Likert-type rating scales. Therefore, the interpreting of the findings in this study should be careful. Further studies, with different statistical methods for dealing with the gathered data, such as "Rasch analysis" (e.g., van Alphen et al, 1993), are also suggested to reconfirm the findings in this study.

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Appendix. Items of the Information Commitments Survey (ICS)

Elaboration as searching strategy (Elaboration)

When I search information on the Internet,

1. I am used to summarize a variety of information.
2. I can use some acquired information for advanced search to find the most-fit information.
3. I can integrate the information obtained from a variety of websites.
4. I can keep reminding myself about the purpose of my searching.
5. I can compare different information from related websites (or pages).

Match as searching strategy (Match)

When I search information on the Internet,

1. I usually only use search engine to find the most-fit websites (or pages).
2. if I find the first relevant website, I will not search others.
3. I am eager to find a single website that contains the most fruitful information.

Multiple sources as correctness (Multiple sources)

When I view some information unknown on the Internet,

1. I will discuss with teachers or peers, and then to judge whether the information is correct.
2. I will explore relevant content from books (or print materials), and then to evaluate whether the information is correct.
3. I will try to find more websites to validate whether the information is correct.

Authority as correctness (Authority)

When I view some information unknown on the Internet,

1. I will believe in its accuracy if the information is posted in famous websites.
2. I will believe in its correctness if the information appears in government websites.
3. I will believe in its accuracy if the information is posted in professional (official) websites.
4. I will believe in its correctness if the information appears in some websites recommended by experts.

Content as usefulness (Content)

When I view or navigate information on the Internet,

1. if its content fits my searching goal, I will think the information is useful to me.
2. if it can provide more related links, the information for me is useful.
3. if it can help me search relevant information further, I will think the information is useful to me.
4. if it is closer to my searching purpose, I will more believe in its usefulness.
5. if it is highly related to my intended searching content, the information for me is useful.

Technical issues as usefulness (Technical)

When I view or navigate information on the Internet,

1. if it is presented by animation, I will think the information is useful to me.
2. if it does not take much time to be retrieved, the information is useful to me.
3. if it does not require password or registration, I will think the information is useful to me.
4. if it is shown in more beautiful websites, I will believe in its usefulness.

Note: The same questionnaire is also presented in Wu and Tsai (2005b).

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Students' Perceptions on Effective Dimensions of Interactive Learning in a Blended Learning Environment

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ABSTRACT
This study investigates students' perceptions of the "effective dimensions of interactive learning" in a hybrid course. A case-study design was used, and 25 students enrolled in "Computer Networks and Communication," a course at a public university in Turkey, formed the sample of this study. The study lasted for 14 weeks. At the end of the study, interviews were conducted to gather data on the "effective dimensions of interactive learning". Additionally, computer logs of the students were kept and analyzed to triangulate the interview data. The findings of the study showed that the way instructivist and constructivist elements are blended, the need for metacognitive support, authentic learning activities, collaboration, type and source of motivation, individualized learning, and access to the Internet played important roles in students' learning in the hybrid course.

Keywords
Blended learning, Hybrid instruction, Effective dimensions of interactive learning

Introduction

There are different opinions on the effect of technology in education. One of the earliest arguments questioning technology's role in learning comes from Clark (1983, 1994). He argues that media (technology) is nothing but a vehicle that delivers instruction, and that technology would not affect student learning. He pointed at the method of instruction as the most important consideration for this aim. Other researchers, such as Russell (1999), Jonassen, Campbell, and Davidson (1994), and Ehrmann (1999), agreed with Clark that focusing purely on the technology would be wrong and that learning should be the center of interest.

Previous research studies show that integrating technology into instruction can definitely improve access to information. However, if the question is "whether technology improves learning," previous research studies indicate that the answer seems to be "no" (Ehrmann, 1999). Russell's (1999) work has similar results. Three hundred distance education studies showed that the learning outcomes from distance education courses were not significantly different from those of traditional courses, indicating "The No Significant Difference Phenomenon."

The inherent problems of online instruction, including the pressure of limited resources (such as time, money, hardware, and software) and the pedagogical problems of purely online or traditional instruction, have led to a new idea: Why not mix the benefits of online courses with the benefits of face-to-face courses? Many instructors supplement their courses with simulations, online exercises, and immediate online feedback, creating richer learning environments through multimedia and hypermedia. The systematic and strategic integration of these tools into courses to meet pedagogical goals introduce a new way of approaching instruction. This new strategy has many names: blended learning, hybrid instruction, mediated learning, web-enhanced instruction or web-assisted instruction.

"Blended learning" and "hybrid instruction" are terms commonly used to label courses that combine face–to-face classroom instruction with online instruction. Blended learning environments aim to combine attributes of online instruction, such as efficiency, sufficiency, and freedom to access information anytime with minimal effort, with attributes of traditional classroom instruction, such as enabling students to work with the new information presented, as well as interact with peers and the teacher in the classroom. For the current study, the terms blended learning and hybrid instruction are used interchangeably and are interpreted as the effort to integrate the social aspect of face-to-face environment with information-access methods of a web-based environment. Although there are differences in the practice of blended learning and hybrid instruction, the idea behind both is to redesign the instruction to maximize the advantages of both face-to-face and online modes of instruction.

However, the literature does not provide much evidence on whether or not this type of instruction is more effective than purely traditional face-to-face courses or purely online courses. Garnham & Kaleta (2002) investigated the hybrid courses of 17 instructors from five different campuses of a state university. The findings revealed that there were no common or accepted standard approaches and teaching methods among the offered hybrid courses. In a parallel study at the same university, Sands (2002) proposed general guidelines for instructors who planned to combine online teaching elements within their courses. No follow-up research on these two studies looked at whether or not these proposals created common standards or increased the effectiveness of these courses. In an earlier study, Marques, Woodbury, Hsu, and Charitos (1998) investigated how well a blended learning environment in another university worked for students' learning with respect to students' experiences. The study indicated that the hybrid model of instruction worked well in spite of the strong dependence on text-based resources. The mixture of electronic and traditional classroom was encouraged and was called "well suited" to the progressive development and implementation of a learning-centered model of instruction. The literature also shows that students' course satisfaction was high in hybrid courses (Gray, 1999; Black, 2002). Several other studies found that students preferred a "mixed" course structure , and that hybrid courses affected students' learning positively (Gunter, 2001; Sanders & Morrison-Shetlar, 2001; Yildirim, 2005). All of these studies provide valuable information in designing blended learning environments, and most of them indicate positive attributes of these environments.

There are no accepted standards for blended learning, and different institutions implement blended learning in different ways. The analysis of such an environment needs to include all of the important attributes in an instructional setting. A model covering the most important dimensions of learning in a blended learning environment is needed. Some models were proposed to ensure effective learning in online learning environments. Models developed by Reeves (2002), Reeves and Reeves (1997), Caladine (1999), and Welsh and Reeves (1997) provide important guidelines for the instructional designers. The model developed by Reeves and Reeves (1997) defines the effective dimensions of interactive learning in the World Wide Web (WWW). The dimensions included in the model were driven from research and theory in instructional technology, cognitive science and adult education. In addition, the model focuses on the pedagogical aspects of online learning (Reeves & Reeves, 1997) rather than on the media and technology components of Web based instruction WBI,. The model is used to understand where the instructional practices are located on continua with contrasting values at two ends for important learning dimensions (supplied in Table 1). The model of Reeves & Reeves (1997) was modified by Reeves in 2002 and developed into a general model for evaluating what really matters in computer-based education. The new model, with 14 dimensions, was referred to as a "systematic evaluation of computer-based education (CBE) in all its various forms (including integrated learning systems, interactive multimedia, interactive learning environments, and microworlds)" (Reeves, 2002, p. 1). Since its dimensions are more generic, the older version of the model was selected as a framework for the current study to understand student perceptions on the important dimensions of a blended learning environment. Out of 10 dimensions in the model, nine, namely: pedagogical philosophy, learning theory, goal orientation, task orientation, source of motivation, teacher role, metacognitive support, collaborative learning strategies and structural flexibility were included in this study.

Even though there is an increase in the number of blended learning environments, and the existing literature generally showed positive attributes of these instructional practices, the field lacks detailed and empirical studies on the effectiveness of the learning process in these environments. Therefore, to see the whole picture and determine the contributing factors to learning in blended learning environments, there is a need to examine hybrid courses from different dimensions and contribute to related literature in this respect. Hence, the aim of this study is to investigate the effective dimensions of interactive learning in a blended learning environment relative to students' perceptions. To investigate this issue, the dimensions of interactive learning in Reeves and Reeves' model (1997) were used as a conceptual framework. The research question that guided this study was: What are students' perceptions about the blended learning environment in terms of effective domains of interactive learning at the end of the study in regard to

- pedagogical philosophy employed,
- the learning theories that formed a base for the hybrid course,
- goal orientation,
- task orientation,
- source of motivation,
- instructor's role,
- metacognitive support,
- collaborative learning strategies, and
- structural flexibility.

Table 1. Effective Dimensions of Interactive Learning on the WWW

Pedagogical Philosophy	***Instructivism*** Knowledge flows from instructor to the student	***Constructivism*** Knowledge is a construct in the mind of the learner
Learning Theory	***Behavioral*** Learning can be seen in observable behavior	***Cognitive*** Learning relies on internal mental states
Goal Orientation	***Sharply Focused*** Instruction with focus on a expected behavior	***General*** Simulation with more than one solution to a problem
Task Orientation	***Academic*** Traditional academic exercises have to be done	***Authentic*** Exercises in authentic settings have to be done
Source of Motivation	***Extrinsic*** Motivation from outside the learner/learning environment	***Intrinsic*** Motivation from inside the learner/learning environment
Teacher Role	***Didactic*** Teacher is the source of knowledge	***Facilitative*** Teacher is the facilitator of instruction, guiding students
Metacognitive Support	***Unsupported*** No support for monitoring progress and adjusting to individual learner's needs	***Integrated*** Supporting learners by helping them monitor and regulate their own learning process.
Collaborative Learning Strategies	***Unsupported*** Learners work individually to accomplish goals	***Integral*** Learners work in pairs/small groups to accomplish goals
Cultural Sensitivity	***Insensitive*** Cultural sensitivities are not taken into consideration while designing the course	***Respectful*** Course is designed to respect and adapt to cultural norms
Structural Flexibility	***Fixed*** Site limited to specific times and/or places	***Open*** Site not limited to specific times and/or places

Method

Design of the Study

A case-study design was used in this study. Effective dimensions of interactive learning in a hybrid course were examined through in-depth interviews with the participants and through the log system, which kept records of students' web-component usage. While qualitative data gathered from the interviews was used to investigate students' perceptions, quantitative data in the form of frequency count and activity durations from the log-system was used to triangulate and support the findings.

Participants

The study included a total of 25 university students enrolled in the "Computer Networks and Communications" elective course at Middle East Technical University in Turkey. The course was designed and offered as a hybrid course. Prior to the study, all students were required to take the course "Introduction to Information Technologies and Applications," which covers computer-literacy topics. The students were from various departments at the university. The study lasted 14 weeks, and during this period, the students met once a week for one hour in class, but essential parts of the course were done online.

Procedures of the Study

A hybrid model of instruction was designed and developed to deliver the content of the "Computer Networks and Communications" course by technological means. This type of instruction was meant to maintain and increase the quality of the instruction by streamlining and rethinking the delivery of course content.

At the beginning of the semester, students were provided with orientation on how to participate in the online part of the course. This orientation covered topics such as how to use the site, website addresses, navigation structures, use of cognitive tools, security policies, and choosing usernames and passwords.

Students were informed about what was expected from them while using the online part of the course. Every student in the hybrid course had to visit the course website and be active online for at least one hour each week. Students' website usage was logged by the log system, and each week, the duration and activities of each student were checked. The students could not just open the page and leave, since the system logged them out after a five-minute inactive time. In the one-hour classroom meeting, students were informed about their online participation.

When students met once a week for one hour in the class, no lecturing was done. Instead, with the guidance of the instructor, class time was used for group and individual activities, educational games, discussion of homework and assignments, questions and answers about the subject, and discussions on term projects.

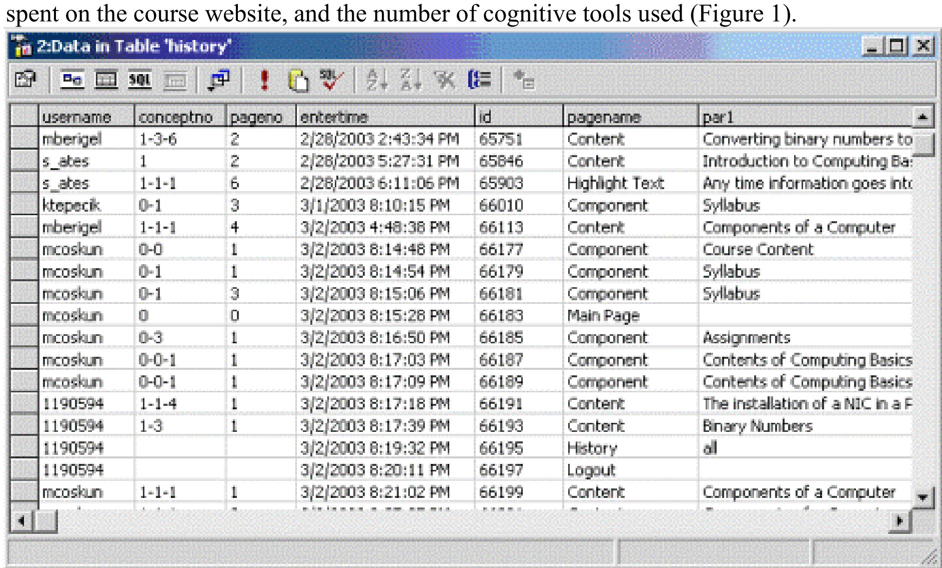
Data Collection

An interview guide was used to collect data on the students' perceptions of the effective dimensions of interactive learning in regard to the hybrid course. Additionally, the log system was used to track the students' activities in the course website to triangulate the interview data.

The interview guide included 24 questions on the effective dimensions of interactive learning: "pedagogical philosophy, learning theory, goal orientation, task orientation, source of motivation, teacher role, metacognitive support, collaborative learning, and structural flexibility" (Reeves and Reeves, 1997). At the beginning of the semester, the interview guide was piloted with two students who took the same course the previous year. Because of time constraints and difficulties in understanding, some of the questions were eliminated and some revisions were done a second time. Two measurement-and-evaluation experts examined the final schedule, and it was found valid for this study.

The students in the hybrid course were interviewed individually at the end of the semester. Each interview lasted about 40–60 minutes. The interviews were tape-recorded with the students' consent.

For triangulation purposes, the log system was used to collect data on students' use of the course website. For each user, the log system recorded the students' online habits, including the time spent on a specific chapter, the total time spent on the course website, and the number of cognitive tools used (Figure 1).


2:Data in Table 'history'

username	conceptno	pageno	entertime	id	pagename	par1
mberigel	1-3-6	2	2/28/2003 2:43:34 PM	65751	Content	Converting binary numbers to
s_ates	1	2	2/28/2003 5:27:31 PM	65846	Content	Introduction to Computing Ba:
s_ates	1-1-1	6	2/28/2003 6:11:06 PM	65903	Highlight Text	Any time information goes int(
ktepecik	0-1	3	3/1/2003 8:10:15 PM	66010	Component	Syllabus
mberigel	1-1-1	4	3/2/2003 4:48:38 PM	66113	Content	Components of a Computer
mcoskun	0-0	1	3/2/2003 8:14:48 PM	66177	Component	Course Content
mcoskun	0-1	1	3/2/2003 8:14:54 PM	66179	Component	Syllabus
mcoskun	0-1	3	3/2/2003 8:15:06 PM	66181	Component	Syllabus
mcoskun	0	0	3/2/2003 8:15:28 PM	66183	Main Page	
mcoskun	0-3	1	3/2/2003 8:16:50 PM	66185	Component	Assignments
mcoskun	0-0-1	1	3/2/2003 8:17:03 PM	66187	Component	Contents of Computing Basics
mcoskun	0-0-1	1	3/2/2003 8:17:09 PM	66189	Component	Contents of Computing Basics
1190594	1-1-4	1	3/2/2003 8:17:18 PM	66191	Content	The installation of a NIC in a F
1190594	1-3	1	3/2/2003 8:17:39 PM	66193	Content	Binary Numbers
1190594			3/2/2003 8:19:32 PM	66195	History	all
1190594			3/2/2003 8:20:11 PM	66197	Logout	
mcoskun	1-1-1	1	3/2/2003 8:21:02 PM	66199	Content	Components of a Computer

Figure 1. The course log system

Data Analysis

Qualitative and quantitative data analysis strategies were performed in the study. The interview data was transcribed, and content analysis was performed to find out meaningful phenomena in regard to students' perceptions of "effective dimensions of interactive learning" (Reeves and Reeves, 1997). Students' responses were interpreted and categorized into the dimensions provided in the Reeves & Reeves (1997) model. For the data in each dimension, data reduction, data display, and conclusion-drawing processes were done (Miles & Huberman, 1994). In data reduction, the interview results were categorized and simplified. In data display, the categorized and simplified results were organized for conclusion drawing. Finally, conclusions were drawn, and then the interpretation and discussion of the results were offered.

The actions that the students performed on the course website were tracked through the log system. The log system kept logs of each student in terms of username, the topics visited, time spent on each topic, login-logout time, history of visited pages, and history of the cognitive tools used. For each user, the quantitative data gathered through the log system were analyzed in regard to the total number of pages visited, duration of time spent on each topic, total number of tool actions, and usage frequency of each cognitive tool.. The frequency and duration for each student were compared with the interview data for triangulation.

The Hybrid Course

The "Computer Networks and Communications" course was designed and developed as a hybrid course for the purpose of this study. The hybrid course required self-paced learning time since the course content was online, creating a significant reduction in classroom lecture time. In designing the hybrid course, formal and informal data gathered from the students who already took the course were examined. In order to determine the content and visual elements of the course website, the desired outcomes of the course in terms of goals and objectives were specified, and content, exercises, and assessment instruments to be included were documented. Because of internal validity concerns, the majority of the visual elements and the content were adapted, with permission, from a commercially well-known information source. As the third step, the graphical user interface of the website was designed. As the last step of creating the website, the content and the visual materials were coded. The website of the course was developed using Active Server Pages (ASP), Microsoft SQL Server 7.0, Dynamic HyperText Markup Language (DHTML), and Cascading Style Sheets (CSS), and it included course content, syllabus, announcements, assignments, forum comments and the cognitive tools Highlight, Bookmark, Notebook, Pagenote, Search, Glossary, History, Sitemap and Note to Remember (Figure 2).

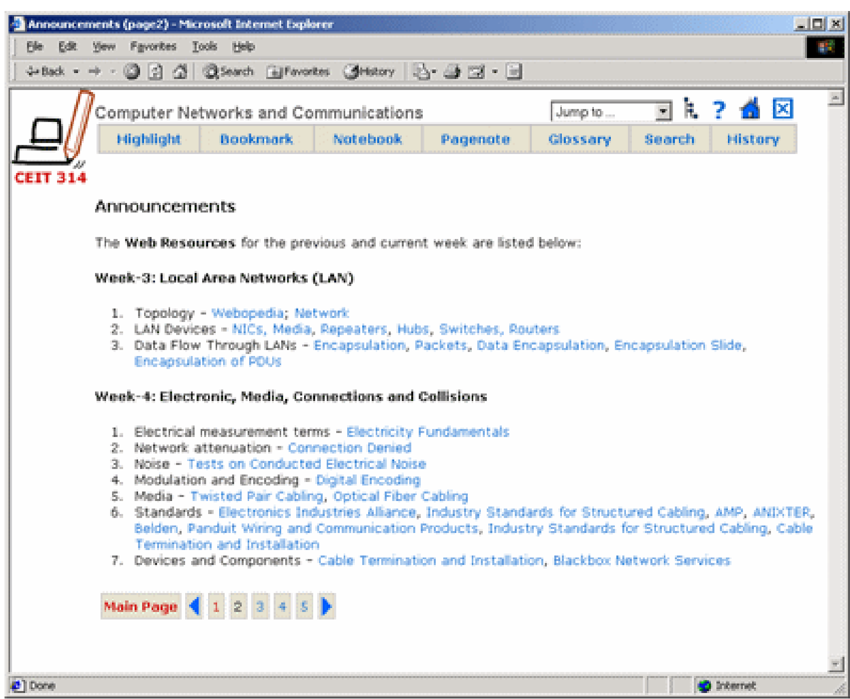


Figure 2. The course website

The website included objectivist/instructivist and constructivist elements. Objectivist structure in terms of content presentation structure in the website was supported by constructivist elements such as cognitive tools and in classroom meetings that included group work, games, discussions, and projects.

The differences in learning and teaching activities between the hybrid course and a traditional course were shown by Caladine's (1999) model, which he called "A Model for Learning and Teaching Activities" (MOLTA). The elements of the hybrid course in regard to MOLTA are summarized in Table 2.

Table 2. The Elements of the Hybrid Course

MOLTA Elements	Hybrid Course (one hour of classroom meeting each week)
Delivery of Material	Website, on-line materials
Interaction with materials	Multimedia, web browsing, web cognitive tools, homework, quizzes, classroom activities
Interaction with the teacher	Web announcements, forum, phone, face-to-face interaction, consultation
Interaction between students	Web forum, e-mail, group work, class discussions, projects
Intra-action	Class discussions, group work, web forum

Results

The students' perceptions of the blended learning environment are important to understanding their preferences in regard to effective dimensions of interactive learning in the hybrid course parallel to Reeves and Reeves' (1997) model.

Pedagogical philosophy and learning theories

The two contrasting values in pedagogical philosophy are instructivism and constructivism. Closely related to these pedagogical philosophies are the learning theories behaviorism and cognitivism. The interview results indicate that while the overall design of the hybrid course is closer to instructivist philosophy, the online part of the course, group work, and classroom discussions and activities are closer to constructivist epistemology (Table 3). The findings showed that the materials and the activities based on both instructivist and constructivist philosophies were found to be beneficial for learning by the students.

Table 3. Students' Perceptions of the Features Based on the Pedagogical Philosophy and Learning Theory of the Hybrid Course

Features/ Components of the Hybrid Course	**Students' Perceptions**	**Pedagogical Philosophy**	**Learning Theory**
Design of the Course (Whole Course)	Successful in relating previous knowledge to newly acquired knowledge.	Instructivist & Constructivist	Behaviorist & Cognitivist
Predetermined Objectives (Whole Course)	Helpful in that they indicated what was expected.	Instructivist	Behaviorist
Learning Habits of Students (Whole Course)	Preferred lecturing and face-to-face communication.	Instructivist	Behaviorist
Time Management (Whole Course)	Nice to come to the class for only one hour. Overall, it was too demanding.	Constructivist	Cognitivist
Quizzes (Face-to-face)	Useful for self-assessment.	Instructivist	Behaviorist
Group Work (Face-to-face)	Helpful to learn from others and reflect on what others knew.	Constructivist	Cognitivist
Announcements & Additional Links (Web)	Learning from different sources was beneficial.	Constructivist	Cognitivist
Assignments & Homework (Web)	Supportive of course content.	Constructivist	Cognitivist

Course Content (Web)	Heavy course load and too much to read. Structured, step by step	Instructivist	Behaviorist
Message Board (Web)	Useful for exchanging web resources.	Constructivist	Cognitivist
Website Usage (Web)	Preferred to study at home on weekends and before class meetings.	Constructivist	Cognitivist
Cognitive Tools (Web)	Useful for organizing learning. Enabled searching and quick and easy access to information.	Constructivist	Cognitivist

Most of the students mentioned that they found the cognitive tools provided in the course website beneficial. One of the students said, "I didn't need anything else than the website of the course to study for this course. I could take notes and underline things that I needed to remember. It was very helpful for me to customize the web pages according to my way of learning."

The students were asked if they could relate new knowledge with their prior knowledge. Most students (N=21) indicated that they could do this to one extent. Only four out of 25 students stated that they couldn't relate their existing knowledge with the newly acquired knowledge. These students claimed that they had no previous knowledge on computers and computer networks. Some students (N=11) mentioned, they could relate or understand relation between a few of the newly learned subjects with their previous knowledge. Seven students stated that they could relate what they learned in the course with what they knew. Three students explained that they had a good background in the computer networks subjects and that they could build everything they learned from the hybrid course on their previous knowledge. The findings of the study showed that the hybrid course was successful in relating previous knowledge to the newly acquired knowledge if the students had previous knowledge.

The course features that support students' learning in the hybrid course were ranked by the students as:

1. Homework and assignments provided through the website (N=24)
2. Announcements and additional links supplied through the website (N=16)
3. Quizzes given in the classroom (N=15)
4. Group works and classroom discussions conducted in the classroom (N=11)
5. Message Board (Forum) in the course website (N=8)

Goal orientation and task orientation

The findings of the study showed that majority of the students found the goal orientation of the hybrid course more sharply focused than general. This was so because course topics were divided according to measurable objectives. Students were satisfied with these pre-determined goals and objectives. Most of them stated that by knowing the goals and objectives they could answer the metacognition related question: "What information do I need to know?" The hierarchic structure of the course website to present information was also pointing towards focused goal orientation structure. On this, one student said: "Each week I knew what I had to learn for that week. I read the website to understand the topic as much as I could. I also knew that we would have activities on these topics in the classroom."

Majority of the students mentioned that they could integrate the focused and general goal orientation strategies while learning. The classroom meetings were based on unfocused goal orientation. One student said, "Every week, we did something like a discussion, watching a film, a group work or a game related to the things we had read that week from the web. Sometimes, I was interested in one of the topics and I asked the instructor for detailed information or for an information source." Some students indicated that the general goal orientation strategies in the projects, assignments and group works helped them acquire the hands on real-life skills of what they read in the course website.

To understand how the students made use of the sharply focused structure of the course contents, we asked them how they used the website throughout the semester. Most students (N=16) first accessed the course content pages when they logged into the course website. After that, the students viewed the assignments and additional links. Lastly they examined the Message Board for anything interesting. Triangulating the students' statements with the log-system records showed that most of the students first visited the main page, then visited the course content, assignments, announcements, and Message Board, as indicated by the students. This could be interpreted as, first the students wanted to achieve the pre-defined, sharply focused goals of the course in terms of content knowledge. Then they wanted to see what was required of them throughout the course, then they investigated the additional links, and last, they asked questions or looked for questions asked by others.

Motivation

The findings of the study showed that motivation and reward are very important for students' learning in the hybrid course. The analysis of the interview data showed that students had both intrinsic and extrinsic motivation. The analysis of the data also pointed towards intrinsic motivation as the key element for the success in the hybrid course.

One indication for intrinsic motivation was "enjoying" the course. Students indicated that even though they enjoyed some learning activities, they did not enjoy reading the content from the website. They enjoyed the real-life experiences, such as installing a cable, configuring a computer or a network device, and making a cabling design for a given building floor plan. They also enjoyed reading and applying real network protocols and addressing schemes like IP. One of the students commented regarding motivation and metacognition, "I always wondered why we configured the computers with IP address and a subnet mask. Now I understand why and how we use them."

Students who indicated a "joy" of learning the topics covered in the course were those with metacognitive abilities that allowed them to understand "what they learned" and "why and how they learned." For example, a student said: "I expected that this course would change my way of understanding the computer-network topic. My expectation became true. Now I look at many things differently. For example, when I enter a computer lab I can determine where the line is going from, where the switch is located, good or bad ways of installation."

The features of the hybrid course the students liked the most:

The content of the hybrid course (N=22): Most of the students found the computer-network subjects interesting. Students stated that they liked to learn about the computer-network subjects, because these subjects would be useful in their professional life. Almost all students said that they would benefit from the course content in the future.

The hybrid structure of the course (N=15): The majority of the students indicated their enjoyment in taking an alternatively delivered course after so many traditional courses. It was something new for them. They stated that they found the course structure interesting and useful. They especially liked the course being neither fully web based nor fully traditional.

The learning/instructional activities done in the classroom (N=15): The majority stated that they prefer doing activities rather than sitting silently and listening to the instructor. They indicated that they enjoyed practicing on the information they read on the website.

The cognitive tools in the course website (N=14): According to student comments, the cognitive tools gave the course website a professional feel, making it different from standard, electronic page-turning websites. One student commented, "The tools in the website were very usable. I used them for accessing information quickly and easily."

The course website (N=12): Half of the students found the website very user-friendly, appealing in terms of graphics, and well organized for accessing information. The students liked the navigation structure and the information-presentation structure.

When the students' interview results on their likes and dislikes are compared, we could see that the students had internal and external motives throughout the course. One common view of students was that the classroom meetings, which included face-to-face communication with the instructor and peers, was a source of motivation. Students indicated that they found interaction with the instructor especially motivating. Regarding the face-to-face component of the course, while some students said that they understood the topics better through interaction with the instructor and their friends, others indicated they liked to talk with others on the course content. Analysis of the interview data pointed towards intrinsic motivation as the key element for success in the hybrid course.

Instructor's role

Students perceived the role of the instructor as a guide in their learning, and a facilitator of the classroom activities. They indicated that they could communicate with the instructor in a friendly manner. The students perceived their role as "active" and the course as student-centered. The student interviews showed that the instructor was an important source of motivation for them. They viewed the instructor as the person who:

- outlined the important points of the course content (information source)
- motivated the students to come to class and read the content (motivation source)
- controlled their assignments, homework, and projects (authority figure, feedback provider)
- helped them in doing their assignments, projects and classroom activities (facilitator)

The findings showed that the instructor's role was closer to constructivist orientation. The instructor provided learning environments open to interaction and communication, and was a facilitator.

Metacognitive support

Students' perceptions of metacognitive support of the hybrid course showed that the course was integrated rather than unsupported. The integration of the cognitive tools to support the students in monitoring, visualizing, and regulating their learning, and searching and accessing information easily and quickly provided metacognitive support for the students in the hybrid course. The cognitive tools enabled students to customize the course website according to their own learning habits. The students could underline important points in the content, take notes while reading, search for a meaning of a technical term or abbreviation, and perform quick access to different parts of the information provided on the course content pages. The most preferred cognitive tools according to the students' interviews were 1) Glossary, 2) Highlight, and 3) History. The log system showed that the most frequently used tools were 1) Highlight, 2) Glossary and 3) History. As stated by the students, cognitive tools helped them in structuring their knowledge and "knowing what they know." Table 4 presents students' use of cognitive tools, and their activity count in the log system.

Table 4. Students' use of cognitive tools

The Cognitive Tool	Number of students stating that they made use of it	Activity count in the Log-system
Glossary	23	438
Highlight	21	1728
History	20	194
Sitemap	18	156
Search	17	123
Bookmark	15	140
Pagenote	13	80
Notebook	10	75

Students indicated that the Glossary and Highlight were the most "helpful" tools in studying for the course. Students' activities in the log system showed similar results. The most frequently used cognitive tool by the students was the Highlight and then the Glossary. Most of the students stated that they used the cognitive tools to underline (highlight) texts, to lookup abbreviations, and to find a specific topic within the content.

There were differences in preferences of students in using the cognitive tools and the frequency of using a tool. Overall, the student perceptions indicated that the course website was integrated in terms of metacognitive support. The important finding of the study was that metacognitive skills of the students in the hybrid course vary in accordance with their achievement goal orientations in the hybrid course. Students are expected to understand their responsibilities and manage their learning by themselves in hybrid courses. In the current study, the metacognition and time management skills of the students were supported through cognitive tools in the website and with a log-system. The interview results and findings of the log system were consistent indicating that students were supported in controlling and regulating their learning in the hybrid course.

Collaborative learning strategies

The face-to-face component of the hybrid course was where most of the collaborative learning strategies were integrated. Students worked in groups, played educational games, and participated in classroom discussions. The

Message Board feature of the course website was also used to create collaboration among students. The students were asked which of these features supported their learning. They stated that the classroom activities affected their learning in a positive way. Students were further asked which of the classroom activities they benefited from most while learning. Students' answers indicated that they benefited most from 1) asking questions about the class discussion to their peers and the instructor, 2) working in groups, 3) playing educational games, and 4) listening to classroom discussions. Students indicated that the Message Board was useful but not as effective in student collaboration as expected. While students perceived the website of the course as more unsupported, they perceived the classroom learning activities as supported in regard to collaborative learning strategies.

Structural flexibility

The interview results indicated that the structural flexibility of the hybrid course and especially the website of the course were open rather than fixed. The majority indicated that they could access information anytime they wanted and there was no restriction regarding time or place since the website was accessible seven days a week, 24 hours a day. With the integration of the cognitive tools, they could easily search, access, and organize knowledge. Through these tools, they could access the same information from different links. Most of the students stated that the course website was user-friendly and that the graphical and navigation features such as buttons, icons, and links were clear, easy to understand, and distinguishable. Access to any information within the course content could be achieved multiple ways. The hierarchical presentation of the content added to the structural flexibility of the course.

Closely related to structural flexibility of the hybrid course was the usability of the course website. Usability refers to the factors that make the experience for the learner simpler and stress free. The usability factors were especially important for the course website, which was a dynamic website prone to technical problems. The download time was also important, since most of the students stated that they prefer to connect to the Internet via modem from home. Students' perceptions about the amount of text in one page and the no-scrolling feature were generally positive. There were only few students who would prefer scrolling on web pages. The graphics were selected with care, and student perceptions showed that the graphics were helpful in understanding abstract concepts. Students stated that they would have liked more simulations and multimedia available on the website. On the other hand, they also wanted to download the pages as quickly as possible because they connected via modem from home and had to pay for the Internet connection time.

Conclusion and discussion

The literature shows that there are fundamental philosophical differences between objectivist and cognitivist learning theories, based on instructivist and constructivist epistemologies (Bednar, Cunningham, Duffy, & Perry, 1995; Dick, 1995; Rowland, 1995). However, in the real classroom environment, a "mix" of objectivist and cognitivist, and inline with that, instructivist and constructivist instruction/learning design, is being used (Davidson, 1998). In the design of the hybrid course, the aim was to produce the best practice by means of key concepts of instructional design, and different parts of each theory were used according to "what," "where," and "how" questions. Our studies indicate that the students found the pedagogical philosophy of the hybrid course to be a mixture of instructivist and constructivist elements. This structure is also recommended by Passerini and Granger (2000) as the ideal paradigm of online-course design. Moreover, as stated by Moreno and Mayer (1999), there is no need for discovery learning to have constructivist learning. Constructing meaning can also be achieved by a well-designed and organized directed learning. This is parallel with what the students indicated related to the pedagogical philosophy. Most of the students found the course was well designed for the aim of hybrid instruction. Students declared that their primary source of information was the course the website, which was closer to objectivist theory. They also indicated that they used other components of the hybrid course for supporting their learning (such as classroom activities and cognitive tools) which were closer to cognitivist learning theory and constructivist philosophy.

The cognitive tools in the course website were successful implementations of the cognitivisit learning theory and constructivist philosophy. The findings indicated that cognitive tools enabled students to process a large amount of information and helped students search for, access, and organize information, important for learning in open-learning environments according to Land and Hannafin (2000). Our study indicated that students needed learning-support tools such as the cognitive tools in the course website in order to interact and become involved in cognitive activities (Clarebout, Elen, Johnson & Shaw, 2002). Learning-support tools provide an overt means through which individuals engage and manipulate both resources and their own ideas (Hannafin, Land, & Oliver, 1999), and structure or assist in the problem-solving process (Clarebout, Elen, Johnson & Shaw, 2002).

The discussion about how much of the course should be online was an issue for the hybrid course in this study. As proposed by Garnham & Kaleta (2002), the amount of online information should be limited. Our findings showed that the information provided online in the hybrid course was "overloaded" and too much. Special attention is needed in both selecting the content and determing the amount of time needed to cover that content in the hybrid course.

Findings point to motivation as an important factor in student achievement. Research evidence indicates that motivation is not only a determinant for students' achievement but that it also has to be activated for each task (Weiner, 1990). The findings of the current study point towards intrinsic motivation as the dominant motivation type in students' learning in the hybrid course. This result supports the findings of Lin and McKeachie (1999, cited in Lee & Park, 2003). They acknowledged that intrinsically motivated students engage in the task more intensively and show better performance than extrinsically motivated students. However, some studies showed opposite results for traditional classroom settings (Frase, Patrick, & Schumer, 1970, cited in Lee & Park, 2003). The contradictory findings have been explained as "possible interaction effects of different types of motivation with different students." For example, "the intrinsic motivation may be more effective for students who are strongly goal oriented like adult learners while extrinsic motivation may be better for students who study because they have to, like many young children" (Lee & Park, 2003, p. 657). Lepper's findings provided evidence that "extrinsic motivators diminish one's interest in learning because the goal becomes the reward rather then their learning" (1985, cited in Alessi and Trollip, 2001, p. 26). Keller argues that the "instructional designer must be proficient at motivation design as well as instructional strategy and content design" (Keller & Suzuki, 1988, cited in Alessi and Trollip, 2001, p. 25). This is especially important in blended-learning environments because the results indicate that extrinsically motivated students in particular tend to lose their motivation. The course website alone was not enough to hold students' motivation high. Students wanted to see their peers, talk to them, share their knowledge and skills, and use their theoretical knowledge in real cases. These activities were effective to motivate students in the hybrid course.

Berge (2000) listed the change in roles of the instructor in constructivist courses as: "from lecturer to consultant, guide, and resource provider; expert questioners, rather than providers of answers; provides structure to student work, encourages self-direction; solitary teacher to a member of learning team". Parallel to this list, some of the changes mentioned by the students indicate that the instructor's role was close to the constructivist epistemology. The students stated that this role supported their achievement, satisfaction, and motivation in the hybrid course.

Previous research studies show that in web-based learning environments, students are expected to access, organize, and analyze information (Jonassen & Grabinger, 1990, cited in Liyoshi, 1999; Newmark 1989, cited in Liyoshi, 1999). The new role of the students puts high cognitive demands on them. The cognitive load has the potential to cause problems in cognitively ill-equipped learners, making them feel "disorientated," and causing "cognitive overload" in such learning environments (Marchionini, 1988; Oren, 1990). As a solution to these problems, the need for metacognitive support was mentioned by Jonassen (1996). Metacognitive support was provided through the cognitive tools in the hybrid course website, and found to be successful in overcoming the students' disorientation and cognitive overload. In addition to decreasing the cognitive load, these tools were implemented to support students' metacognition while they learned from the hybrid-course website. As indicated by Land and Hannafin (2000), they were important factors for learning in open-learning environments, which were described as environments in which students need to process a large amount of information. Cognitive tools are required in these environments to provide help to the students in searching, accessing, and organizing information. Liyoshi, Hannafin, and Wang (2005) implied that even though student-centered learning environments have drawn attention, such systems put an extraordinary cognitive burden on the learner. They suggest that cognitive tools can help learners in such learning environments.

The students' preference for collaboration, especially in classroom meetings, points towards the social aspect of collaboration. In his social learning theory, Bandura (1975) emphasizes modeling of behaviors, attitudes, and emotional reactions while doing purposive, goal-directed activities in a collaborative group. Students' behaviors, attitudes, and emotions affected others while working in groups, discussing a concept, or playing educational games. A similar notion was outlined by Vygotsky (1978) by claiming that social interaction is fundamental in cognitive development. The collaborative classroom environment in the blended learning environment provided opportunities for the social interaction of students.

The usability and simplicity of design was given a special attention in the creation of the course website. Nielsen (2000, cited in Hall et al., 2001) advocates that web design should not include graphics and sounds unless they are absolutely essential. The design of the website of the hybrid course was inline with the literature (Hall et al., 2001) to assure delivery of information simply and quickly without any unnecessary audio and visual elements. The students' perceptions were inline with the stated literature in that the majority found the website easy to use. Additionally, rather than studying from the course Web site, students stated that they wanted to download the pages to their computers as quickly as possible because they connected from their homes via modem and had to pay for the Internet connection time. With the implementation and wide use of new Wide Area Network technologies such as ADSL, this problem can be solved in the near future.

Implications

The design, development, and implementation processes for a blended learning environment are different from those in a purely traditional, face-to-face lecturing course or a purely web-based course. From the results of this study, the following suggestions are made for the development and implementation of hybrid instruction:

- Don't hybridize only the technologies; hybridize the pedagogical philosophies, theories, and instructional-design methodologies.
- Give special attention to student motivation in hybrid courses.
- Provide tools for metacognitive support.
- Use multimedia in the web component to enhance learning
- Encourage and provide facilities for student-student and student-instructor communication.
- Provide students with online self-assessment tools.
- Provide print materials.

Even though the above suggestions are made based on the findings of this study, one needs to be cautious in generalizing these findings in other contexts. The content of the "computer networks and communication" subject is technical, procedural, and well-structured. Other subjects, especially ill-structured subjects, may require different design in a blended learning environment. Therefore, additional research studies that examine effective dimensions of interactive learning in a blended learning environment with different learners and in different subject area are needed.

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e-Lectures for Flexible Learning: a Study on their Learning Efficiency

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ABSTRACT

This study investigates the level of students' learning when using e-lectures to increase the flexibility of the learning experience. Two cohorts of students were presented with the same material in lecture format. The control group attended a traditional live lecture, while the treatment group was offered an e-lecture with the same content. Both groups were asked to work on specific review questions and encouraged to pose their own, as preparation for a knowledge-acquisition post-test. There were no significant differences in post-intervention measures regarding students' level of knowledge, but students in the e-lecture group (lacking immediate teacher-student communication) employed a strongly acquisitive mode of learning, thus undermining teacher-student dialogue later in classroom. The results of this study indicate that students may learn efficiently at the introductory level by using e-lecturing material and they are also satisfied by the flexibility of the experience. However, the adoption of e-lectures to support flexible learning should be explored in close relationship to models of course re-engineering that also foster instructional cohesiveness, by integrating the various learning events as interrelated nodes of a productive learning network.

Keywords

Digitized lectures, e-Lectures, Flexible learning, Blended learning, Media in education

Introduction

Although lecturing is frequently criticized as a passive mode of instruction, strongly based on the idea of "knowledge to be transmitted," it still constitutes a major mode of teaching. It is "a defining element of most university courses" (Bell et al., 2001) "probably because it serves many functions not so well observed in the present research" (Fritze & Nordkvelle, 2003, p. 328). Nowadays, as a means of instruction, digital technology offers the possibility of easily transferring online the experience of the lecture. In most cases this comprises an audio or video feed of the lecture accompanied by a synchronized presentation of supporting material (lecture notes or electronic slides). An increasing number of institutions are reported to include such technology-delivered lectures in their distance-learning courses (Rui et al., 2004), and several studies explore the efficiency of using digital versions of lectures in various instructional scenarios (Spickard et al., 2002; Dev et al., 2000; Bell et al. 2001).

Digital lectures increase learning flexibility as students can easily access online material and reuse it as needed. Technological advances support the efficient development of digital lecturing material by making widely available both the necessary hardware (e.g. Joukov et al., 2003) and the appropriate software for easily viewing digital lectures (for example, the BMRC Lecture Browser).

In the context of this work, we use three different terms to classify the various formats of technology-delivered lectures.

- **Digital lecture**: any lecture delivered through digital technology, either online (synchronously) or on demand (asynchronously). In the former, students attend, from a distance, a live lecture transmitted to them through network services, while in the latter, a digitized version of the lecture is available via streaming technology or optical storage media (CD, DVD). Digital lectures can be captured either "in vivo" or "in vitro" (Wofford et al., 2001, see below).
- **Live digitized lecture (LDL)**: any digital learning resource that captures the experience of lecture-based instruction in the classroom, with students participating ("in vivo"). An LDL is simply a digital version of the live event (the instructor addresses the students who are physically present in the classroom).
- **e-Lecture**: any digital learning resource in lecture format, captured in the studio ("in vitro") with only the necessary technical personnel and with the purpose of engaging students in e-learning experiences. The lecturer addresses a virtual audience, that is, the students who will potentially attend the lecture at a later time. Distinguishing between LDLs and e-lectures is essentially a socio-cognitive issue rather than a technical issue. The reason for making the distinction will become evident later in this article.

We also make use of the "flexible learning" and "blended learning" notions:

- **Flexible learning**: Learners are offered a variety of options for personalizing the learning experience based on their specific needs and preferences. To increase flexibility, therefore, means essentially to overcome obstacles emerging from the rigidity of traditional forms of education by enabling learners to select what is best for them with respect to key dimensions of learning (Collis & Moonen, 2001).
- **Blended learning**: Activities that combine classroom learning with web-based instruction (Whitelock & Jelfs, 2003). It is not, however, the simple aggregate of face-to-face and technology-enhanced learning. Instead, blended learning emerges from the functional integration of the two instructional modes, which in practice means that "blended learning courses have the potential to offer the convenience and flexibility of online courses yet still maintain the interactivity and face-to-face contact offered through traditional courses" (Jones et al., 2003, p. 43).

Along with other researchers, we maintain that the idea of transforming traditional lectures to digital format has some compelling advantages with regard to cost and flexibility. Instructors have the option of digitizing their classroom activities and making them readily available to students beyond place and time constraints, thus increasing flexibility of learning. Furthermore, once produced, digital lectures may always be available on demand, increasing the cost/performance ratio of e-learning services.

However, we argue that technology-delivered lectures should be made available to students only through a cautious exploration of applicable pedagogical scenarios on how to engage students in fruitful learning interactions supported by this specific technology. Following this rationale, we suggest that an interesting option in tapping the potential of audiovisual digital resources is to develop thematically focused, short e-lectures. These e-lectures should concisely present well-seasoned topics that need not to be regularly updated and may be offered to students as introductory material to engage them in blended-learning activities. Instructors can develop this kind of material using simple studio facilities and with ample time to work on improving their lecturing style. In our study we investigate the issue of students' learning when using such e-lecture material for preparation in a blended learning design, addressing two specific questions:

- Are e-lectures as efficient as traditional lectures for students' learning?
- What is the level of students' satisfaction and the attitudes they develop regarding the use of e-lectures?

Literature Review

Comparative studies of live and technology-delivered lectures appeared in the epoch of early TV and video tapes, long before digital technology was widely available. Schramm, in summarizing the results of more than 400 studies comparing televised and classroom lectures, concludes confidently that students learn from technology-supported environments quickly and efficiently (Schramm, 1962, cited in Saba, 2000). Ellis & Mathis (1985) report twelve studies from as early as 1957 that fail to identify any significant difference between students who attend live lectures and those who attend televised lectures. The authors claim that "students can learn introductory college material as well from video-taped lectures as from lectures taught in-person." (Ellis & Mathis, 1985, p. 171).

More recently, Wofford et al. (2001) argue that moving the traditional clinical lecture to the computer,should be an appropriate strategy for efficiently dealing with cost-containment pressures in education. The authors review eight studies concerning medical education. These studies compare the live lecture not specifically to the digital lecture but to various other design interventions based on computer technology (some of them being multimedia computer presentations). Six of these studies show no difference in effectiveness, while two of them favor the computer-based strategy. The authors conclude that digital lectures should be no less effective than traditional lectures.

Several other studies also focus on the use of digital lectures in medical education, highlighting the need for reusable and flexibly accessible learning resources in this specific field. Spickard et al. (2002) examine the effect of using e-lectures to deliver medical curricular content to students who participate in an outpatient clerkship. The control group attended a traditional live lecture, while the treatment group was offered the possibility of viewing an Internet-based PowerPoint presentation synchronized with an audio feed (lecturer's narration). No differences were found in the different groups' learning, and the authors argue that an online lecture is a feasible, efficient, and effective method for instruction. Moreover, they encourage the direct comparison between digital and live lecture format, emphasizing that such studies seem to be fairly limited in number.

Dev et al. (2000) at the Stanford University School of Medicine employed the digital-lecture-as-study-supplement approach and made available to students a streaming video capture of the classroom event. In analyzing usage patterns, researchers observed that students used the video material for review (particularly before course examinations) and not to replace classroom attendance. Although some faculty reportedly complained that video lectures contributed to poor attendance and gave students confidence to skip classes, the authors insist that this is not the case.

However, in a similar study regarding a first-year university computer-studies course, the effect of students' skipping classes was rather intense (Bell et al., 2001). Moreover, students did not access the live digitized lectures (at least to the degree expected) although they intended to do so (according to their statements). The authors conclude that too much flexibility can have a negative affect on learning.

Overall, studies in the literature indicate that:

- Digital lectures may exhibit a variety of features: be available online (synchronously) or on demand (asynchronously), captured in vivo or in vitro, comprise various representational codes and modalities (audio vs. video feed).
- Direct comparisons between live lectures and those that are technology delivered (televised or computerized) result generally in insignificant differences in learning outcomes.
- Incorporating digitized classroom lectures as a supplement to university courses garnered mixed results and may have increased the risk of poor attendance.

Despite the fact that the overall picture emerging from these studies is rather encouraging, we argue that the integration of digital lectures in the curriculum should not be considered a simple and straightforward enterprise without critical considerations. First, although one may conceptualize all types of lectures (live, LDLs, e-lectures) as being structurally isomorphic, research indicates that the context of delivery strongly affects the format of the lecture, inducing changes in the way that the lecturer makes use of various social and cognitive aspects (such as humour, gestures, and instructional examples) (Fritze & Nordkvelle, 2003). In lectures captured in vitro and addressing a virtual audience (such as video-lectures and e-lectures), the lecturer adopts a different social role, more as a representative of the scientific community rather than as an educator. Presumably such (and possibly other) variations may in turn have an effect on the way that lectures of various formats can be optimally integrated in the learning process. This, we suggest, is an important reason for distinguishing between lectures based not simply on the delivery medium but also on their different socio-cognitive underpinnings.

Second, capturing a live lecture is still of considerable cost due to the necessary infrastructure and experienced technical staff (Rui et al., 2004), even though the development of reusable digital material is generally expected to reduce the overall cost of delivering online learning (Wofford et al., 2001). Third, producing an LDL can be a time-consuming task. Dev et al. (2000) point out that preparing the digital lecture material may well demand three times as much time as the length of the live lecture. (Of course, this ratio varies depending on the technology and the post-production processing of the video feed). Hence, updating a course to include lengthy digitized lectures, may become a time-consuming and costly enterprise.

Finally, the experience reported by Bell et al. (2001) shows clearly that the availability of digitized lectures as an alternative, involves the risk of discouraging students from attending the live event and minimizing teacher-student interaction. This is a strong indication that flexibility should not become the sole objective when re-engineering a course. We discuss this point more comprehensively in the next section, in our effort to conceptualize how to build constructive boundaries for flexibility-generated detrimental effects in learning.

Establishing cohesiveness

If being flexible means primarily to provide options for learners, then being cohesive refers to applying an adequate pedagogical framework that adds instructional value to learners' options by projecting these options as interlinked nodes in a network of learning events. In such a network, the degree of cohesiveness (or interconnectedness) between any two events is related to the importance assigned by a learner to event A as a prerequisite for B. Considering A a required step before proceeding to B increases the perceived cohesiveness of the events and enhances the structure of the whole learning experience, albeit lowering flexibility (event B may not be available or the learner may not wish to participate in B if A is not first completed). Cohesiveness reflects the effect of both externally applied constraints (relative to curriculum or the instructional design) and the learners' internal beliefs (such as the students' perceived instructional value of an activity in relation to course objectives). It also offers a measure of students' commitment to participating in a specific learning event (or a sequence of events).

Increasing flexibility by integrating digital lectures may strongly affect the cohesiveness between various learning events, since using a different medium can alter students' priorities for participating in certain events. When offering the digitized lectures simply as study supplement, it is possible that students will interpret this as a decrease in cohesiveness between the live lecture and course assessment events and may skip classes because they are confident that an adequate level of performance can be achieved by another mode of participation (i.e., viewing the digital lectures). This, we believe, is more likely to happen if the opportunity for constructive teacher-student interaction is missed by the instructor in the live event.

Fostering cohesiveness in this case would mean establishing conditions for ensuring that learners are engaged in an adequate level of interaction and information processing, independent of their preferred option for learning. For example, the cohesiveness between the live lecture and students' successful performance can be enhanced by increasing teacher-student dialogue during the lecture. Likewise, the degree of cohesiveness in a learning design that includes digital lectures can be increased by introducing an online post-lecture activity suitable for the students who missed the live event and viewed the digital version instead.

Instructional cohesiveness, therefore, embodies the simple but essential idea that any learning option should be embedded in a framework of learning activities that guarantee conditions of efficient learning.

Integrating e-lectures in blended learning activities

In line with our view to productively combine flexibility and cohesiveness, we argue that a promising model towards this direction is the "before-during-after" model for course re-engineering (Collis & Moonen, 2001). The model suggests that students are engaged in some kind of preparatory learning activity (the "before" event) prior to their participation in a focal activity (the "during" event), to be followed up by some appropriate concluding activity (the "after" event). A popular implementation of the model includes conducting the focal event face to face (F2F) and dividing the rest of the instructional time between online "before" and "after" activities. This establishes cohesiveness through the "before-during-after" linking of the events and supports flexibility by making a significant part of the learning experience available online.

Following this perspective, our study explores the scenario of an instructor who wishes to deliver the "before" event online, having her students informed on the basics of the topic prior to the focal event in the classroom. She anticipates that in this way a certain part of F2F lecturing time (usually devoted to presenting introductory issues) can be freed and invested in more productive learning activities. She knows that a well-organized multimedia presentation can be more appealing to students and also instructionally more effective when compared to a mono-media presentation. Keeping in mind that short e-lectures are more likely to maintain students' attention (Campbell et al., 2004), she opts for shooting some "mini" e-lectures to introduce the course major topics. She then asks her students to view an e-lecture in order to prepare themselves for an elaboration session to be held in classroom.

However, the instructor believes that e-lectures should not be considered equivalent to traditional live lectures because of the several interrelated socio-cognitive factors that affect learning. In a live lecture the presence of an authoritative and facilitating persona (instructor) may motivate the students to attend and cognitively process the presented information. On the contrary, when viewing an e-lecture, there is always the risk that learners may miss some critical point or not process the information effectively if they lack the stimulation of the live event or they are distracted by accidental environmental disturbances (even though the e-lecture can be viewed several times). Furthermore, a live lecture provides (at least in principle) an opportunity for uninterrupted and constructive teacher-student dialogue, thus being a considerably more dialogue-oriented learning activity compared to the rather content-oriented experiences offered by technology-delivered lectures (Fritze & Nordkvelle, 2003). Teacher-student interaction is expected to improve students' understanding in a live event and should be somehow compensated for when using e-lectures.

Within this context of re-engineering considerations, the instructor is interested to know (a) whether her students will be equally well-prepared when using e-lectures (in comparison to traditional classroom lectures), and (b) if this will be a satisfactory experience for the students.

Method

Participants and context

To answer the above questions we conducted a completely randomized one factor–two treatment study. Fifty-three (53) students enrolled in the Multimedia Systems course in the 6th semester of their studies volunteered to participate. This course is a required course, and the topic of instruction (JPEG-compression scheme) is one of the most important covered (along with other image-, sound-, and video-compression schemes). In return for volunteering, students were offered a bonus grade for the course, provided that they obtained at least a passing grade in the post-test of the study.

Typically, the instruction of this topic involves a lecture that presents to students a model of the compression scheme. Emphasis is on raising students' understanding of how the original digital image signal is compressed through a series of appropriate transformations. No deeper mathematical analysis is involved at this level but rather an introductory qualitative approach is followed. This means that the learning objectives are relative to the first two cognitive processes in Bloom's revised taxonomy (Anderson et al., 2001), namely remembering and understanding factual and conceptual knowledge. Later on the course shifts focus to higher levels as well (application and evaluation) but this is outside the scope of this study.

Students were completely randomly allocated to either an experimental or a control group, stratified by gender (*experimental*: 26 students, 9 female; *control*: 27 students, 10 female). The control group attended a typical live lecture that provided ample opportunity for teacher-student interaction (reviewing the lecture material through discussion). The same content was presented to the experimental group in e-lecture format (video feed of the lecturer synchronized with PowerPoint slides). To compensate for the lack of immediate teacher-student communication, students in this group later met the instructor in the classroom for a face-to-face discussion similar to one that occurs in the live lecture group.

Our study evaluated students' learning immediately after these connected learning events (viewing the lecture and interacting with the instructor). The independent variable was the mode of students' preparation (live, interactive lecture vs. e-lecture combined with classroom meeting), while the dependent variables were students' learning outcomes as measured by a post-test questionnaire. Our null hypothesis (H_0) was that students who study by viewing an e-lecture and participating in a F2F review meeting perform equally well in a test of basic understanding as those who attend a live, interactive lecture, provided that they are appropriately motivated and the level of instruction is introductory.

Control Condition

The study was organized in four phases:

1. *Pre-test*: To verify that students were novices and stratification was successful, students were asked to complete a pre-test knowledge instrument. This was a six- item questionnaire comprising short-answer introductory domain questions.
2. *Study*: Students in the control group attended a traditional lecture in a classroom. During the lecture, PowerPoint slides were used to present textual information, graphics, and a few animations.
3. *Review*: Immediately after the lecture, students were given six review questions to answer. They were also asked to freely pose their own questions and discuss them with the instructor. After discussing and providing satisfactory answers to all of these questions, students took the post-test.
4. *Post-test*: To record students' level of learning a five-item questionnaire was used. This post-test instrument comprised open-ended questions asking students to provide a well-supported answer in a few sentences (see Appendix). No other instrument was given to the control group.

Treatment condition

The study of the e-lecture group was also organized in four phases:

1. *Pre-test*: The same six-item pre-test questionnaire was administered to this group.
2. *Study*: One week before the scheduled classroom meeting, students were instructed to view the e-lecture at home, as many times as they wished, in order to get well prepared for their post-test examination. They were given the same six review questions as the control group and they were asked to have their answers prepared (as well as any further questions they wanted to pose) for the review F2F meeting. The e-lectures were

available on a web server for downloading, but were also given to students on a CD to avoid dissatisfaction because of possible technical problems (slow downloading due to low bandwidth connections, for example). Students were presented with two e-lectures: one on the topic of digitization and another on the topic of the JPEG-compression scheme. They were aware that the final test was only on the JPEG topic, but we decided to offer two e-lectures to encourage students to become familiar with this presentation format.

3. *Review*: Students met the instructor in classroom and presented their answers to the six review questions. They also posed their own questions to the instructor. After complete answers were given, they took the post-test.
4. *Post-test*: The same post-test instrument (six open-ended questions) was given to this group. Furthermore, we asked students to complete a seven-item Likert-scale questionnaire to record their attitudes regarding the e-lecture experience. Along with that we asked students to explicitly report what they liked most and what they liked least about the experience.

Results

Pre-test

The pre-test confirmed that students in both groups were novices at the same level, with regard to their previous domain knowledge (control group: *n*=27, M=1.4, SD=1.48, maximum possible score was 18; experimental group: n=26, M=1.3, SD=1.16, t(51)=-.374, p=.71, Cronbach's a=.349).

Study

The live lecture was about 14 minutes, while the e-lecture was 8.37 minutes. This difference was due to the slower pace of presentation in the live lecture. However, the students in the experimental group reported viewing the e-lecture about 3 times (M=2.94, SD=1.20), thus resulting in a total e-lecture viewing time of 24.6 minutes.

The review phase for the live-lecture group lasted about 27 minutes (answering both review and the students' own questions). For the experimental group the respective time interval was about 11 minutes. Therefore, the duration of the whole activity for the live-lecture group was 41 minutes (14+27) while for the treatment group it was approximately 35.6 minutes (24.6+11).

The answers that students gave to the review questions were quite satisfactory for both groups (no formal record available). Students in the e-lecture group, however, posed significantly fewer questions (three questions) than the live-lecture group (nine questions). None of these three questions was similar to those posed by the live-lecture group. A subjective instructor's impression is that students in live-lecture group were significantly more willing to pose questions and further discuss issues on the presented topic before going on to take the final test.

Post-test

Immediately after the review phase, students in both groups were given the post-test questionnaire and were asked to complete it within 20 minutes. This proved to be enough time for the students in both groups.

Table 1. Results of t-test between the two groups

<table>
<tr><th></th><th>Mean (SD)</th><th>t-test</th><th>Significance</th><th>Equality of variance</th><th>Normality</th><th>Reliability</th></tr>
<tr><td>Control group (live lecture) (n=27)</td><td>12.65
(2.74)</td><td rowspan="2">Two-tailed</td><td rowspan="2">No

t(51)=.644
p=.522</td><td rowspan="2">Yes

F=2.024
p=.161</td><td rowspan="2">Yes

Control (n=27)
Z=1.116, p=.166
Exp. (n=26)
Z=.884, p=.416</td><td rowspan="2">Moderate

Cronbach's
a=.636</td></tr>
<tr><td>Experimental group (e-lecture) (n=26)</td><td>13.08
(2.04)</td></tr>
</table>

Two independent evaluators (experienced in assessing students' previous work in the same course) assessed the students' answers and assigned grades according to the following scale: 3=accepted (correct answer, well presented and explained); 2=minor revisions (acceptable answer, correct path of reasoning in general, but some elements missing); 1=major revisions (non-acceptable answer and incorrect path of reasoning in general, but some elements in students' answers, seen in isolation, were acceptable); 0=rejected (completely wrong answer or no answer at all).

The results of the post-test are presented in Table 1. Significant differences between the two groups were assessed using an independent two-tailed Student's t-test. The a-level was set to 5%.

Students' attitude questionnaire

Students' attitudes towards learning from the e-lecture are presented in Table 2. A five-step Likert scale was used in this instrument (1=STRONGLY DISAGREE, 2=DISAGREE, 3=UNDECIDED, 4=AGREE, 5=COMPLETELY AGREE). Students' likes and dislikes (major positive and negative aspects of the experience) are presented in Tables 3 and 4 (free-text answers ranked by the number of occurrences).

Table 2. Students' answers to attitude questionnaire regarding the e-lecture experience (n=26).

Item No.	STATEMENT	Mean
1	I consider the digitized lecture that I viewed as a positive learning experience	4.94 STRONGLY AGREE
2	Technically, the quality of the e-lecture was completely satisfactory	4.35 AGREE
3	I think that learning from e-lectures is in no aspect inferior compared to learning from a live lecture, considering the presentation and transmission of information	3.42 UNDECIDED
4	I think it is important to develop online e-lecture libraries for a course so that I can view an e-lecture any time I wish during the semester	4.88 STRONGLY AGREE
5	After viewing the e-lecture I believe it is necessary to, somehow, ask questions to the instructor (for example, meeting him/her later in the classroom)	4.82 STRONGLY AGREE
6	I think that viewing an e-lecture at home as many times as I wish gives me the opportunity to better reflect on the content of the lecture	4.88 STRONGLY AGREE
7	I believe that combining e-lectures and classroom meetings for discussion (or other review and elaboration activities) can be a better learning experience compared to the integrated traditional lecture in the classroom	4.49 AGREE

Table 3. Positive aspects of the e-lecture experience

Item No.	Students Reporting (n=26)	FREQ.	This aspect relates to…[1]		
			F	C	M
1	Watching the e-lecture as many times one wishes results to better learning	15	x	x	
2	Ample time to get prepared and pose better stated questions	3	x	x	
3	Better study conditions at home (feel more comfortable, better able to concentrate, do not get tired as in classroom, follow one's own pace)	3	x	x	
4	With digitized lectures available one does not miss the lecturing event	2	x		
5	Able to review the e-lecture material without bothering the teacher	1	x		
6	Feel motivated by the use of audiovisual technology	1			x
7	e-Lecture enables participation and so it is more interesting	1	x		x
	TOTAL	26	25	21	2

[1] F=Flexibility, C=Cognition, M=Motivation

Table 4. Negative aspects of the e-lecture experience

Item No.	Students Reporting (n=26)	FREQ.	This aspect relates to…		
			F	C	M
1	Lack of immediate discussion while viewing the e-lecture (students may forget questions they wish to ask, not bother to ask them at all or misunderstand some point in e-lecture)	20		x	
2	Excessive comfort at home and availability of the e-lecture may promote procrastination	2	x	x	
3	More pleasant to attend a live lecture than a digitized one	1			x
4	When e-lectures become an everyday routine they may lose their appeal	1			x

5	Better to have both live lectures and e-lectures (as supporting material)	1	x	x	
6	I cannot find any negatives. Personally, I like the idea and I would like it to be applied.	1			
	TOTAL	26	3	23	2

Discussion

Study design

In this study we have argued that while striving for flexibility one should also establish cohesiveness of the various learning events. In implementing this approach we explored the efficiency of short and thematically focused e-lectures as introductory learning material within the context of specific blended learning activities. Regarding previous studies, our design is different in some critical aspects:

- Unlike Spickard et al. (2002), we included a live teacher-student dialogue component both for control and treatment groups. This feature adds ecological validity to our approach since most instructional designs are expected to include such teacher-student interaction to facilitate learning.
- Unlike Dev et al. (2000) and Bell et al. (2001), we offered the e-lecture as study material and not as an optional review resource. Our research therefore provides evidence about the actual potential of e-lectures to support learning and not simply about the patterns of their possible usage by students.

Furthermore, it is worth emphasizing that although this study generally follows a formal experimentation design, aspects of a more naturalistic design are also implemented (such as the fact that students in the e-lecture group were allowed to view the e-lecture many times, while students in control group attended the live lecture only once). We do not consider this as a design flaw. Contrary, we argue that research should aim at simulating authentic situations as much as possible, thus providing evidence on the efficiency of instructional designs in real-world conditions.

Interpretation of results

Quantitative data indicate that there is no significant difference in the learning outcomes of the two groups as measured by a post-test questionnaire, similar to questionnairs that an instructor would use to determine the students' level of understanding. Our null hypothesis, therefore, holds true, and we conclude that students may learn equally well either from a live-lecture or an e-lecture experience, provided that (a) they are motivated (for example, by grade) and (b) instruction is at the introductory level. However, in generalizing this conclusion one should keep in mind that the students who participated, being computer science students, were keen to use computers for working and learning.

Qualitative data, on the other hand, reveal a lower level of teacher-student dialogue during the F2F part of the blended learning activity. Possible reasons for that may include:

- Students would like to pose questions while viewing the e-lecture but they did not bother to take any notes (although they were instructed to do so) and it was difficult to recall their questions when they returned to the classroom .
- Students opted for reviewing the digital material as many times as they felt necessary and did not really expect much support from the delayed teacher-student dialogue. When in the classroom they felt that no further discussion was needed for getting adequately prepared for their introductory-level test.
- The live lecture experience encouraged teacher-student dialogue as a means for attaining deeper understanding of the presented material.

Although no other data has been recorded to help us more accurately model the relative impact of the aforementioned causes on students' observed behavior, we suggest that the combined effect of the latter two should be considered responsible. Students certainly had a concrete motive to attain a firm understanding of the lecture content and get a good grade in their test. Those in the live lecture, not being able to review parts of the lecture, posed questions and discussed issues with the instructor. The role of lecturer primarily as an educator created a socio-cognitive environment that encouraged students to adopt a more participatory and dialogue-oriented attitude in order to ensure an adequate level of understanding. Those in the e-lecture group, however, lacking any immediate communication with the instructor who acted principally as a presenting scientist, developed a positive attitude toward memorizing and understanding information by reviewing the e-lecture several times. As other studies also emphasize (for example, Spickard et al., 2002), it is possible that group discussion was considered (and eventually proved to be) less needed to achieve students' learning goals. Overall, it seems that (i) the possibility for multiple reviews of the e-lecture, (ii) the perceived role of the instructor, (iii) the spatiotemporal separation between study and live interaction phases, and (iv) the less demanding level of introductory instruction encouraged students in the e-lecture group to adopt a strongly acquisitive mode of learning in their effort to get prepared for the post-test as adequately as possible.

These considerations offer support to the tentative statement that the way that learning activities are allotted to the various media has an effect on students' learning, since any particular media feature may encourage and amplify certain learning attitudes, depending on students' beliefs about its supportive role towards achieving the learning objectives. If this is so, then fostering only cohesiveness of learning design should not be considered adequate. Care should also be taken to efficiently match the attributes of the media used for delivery to the sociocognitive conditions favorable to any specific learning activity. We refer to this notion as "media suitability," and we argue that this and cohesiveness should be considered two important design pillars of blended learning activities.

Students' answers to the attitude questionnaires (Tables 2, 3, and 4) indicate that although students managed to deal successfully with the learning situation, they nevertheless think of the delayed teacher-student communication as a negative aspect of the experience (Table 4, item 1). Their dissatisfaction is also evident in the low rating of item 3 in Table 2. This is an indication in favor of providing technology-supported communication to students when using e-lectures. We think that ideally students should be supported by some asynchronous service (for example, a forum), since using synchronous services would further reduce flexibility.

Some other issues that students report as shortcomings of their e-lecture experience have already been reported in the literature, such as the risk of procrastination due to excessive flexibility (Bell et al., 2001) and a possible lack of motivation when the use of such material becomes an everyday routine (Clark & Craig, 1992) (Table 4, items 2 & 4).

However, students do acknowledge that using e-lectures has some important advantages considering the flexibility of delivery and related learning benefits (see Table 3, items 1–3 and also Table 2, items 4 & 6). In general, students seem to be pleased by the whole experience (Table 2, item 1) and welcome the availability of e-lectures as learning material (Table 2, item 4), but also emphasize the importance of teacher-student communication (Table 2, item 5), highlighting the need for improvement in this specific instructional design to enable students to fully benefit from e-lectures.

Limitations & future research

In this study, we focused on instruction at an introductory level, encouraging however a strongly acquisitive, albeit sufficient, learning attitude. Future experimentation should explore alternative designs aiming at higher levels of learning as well (e.g. analyze, evaluate, and create). A focal question here is if and how a contribution-oriented instructional design can take advantage of e-lecturing material and establish cohesiveness among online and onsite activities. An interesting possibility would be to have the e-lecturing instructor support the students' individual or group work by modeling, for example, the construction of a deliverable. Online communication services can be used for supporting extensive teacher-student interaction, and the coaching instructor can later bring into the classroom the major issues emerging during the online activities, thus developing a bridge between the online and the F2F components of the learning experience.

We have also argued that establishing cohesiveness and media suitability should be considered important steps in the blended-learning design process. Research is needed to elaborate on these issues and better model the process. For example, it is interesting to investigate whether the e-lecture experience can become more dialogue-oriented if students are offered simultaneously the opportunity of online communication with the instructor, instead of postponing it to take place in classroom. A possible positive answer would offer further support to the notion of media suitability, indicating that the way of distributing activities over media affects the learning attitudes that students develop when engaged in the activities.

Finally, an important limitation of our study is the students' background (they were positively biased towards using digital technology as a means for learning) and the fact that their learning styles have not been taken into account in any way. It is questionable whether the same results can be obtained with students of a different background. Moreover, since e-lectures and live lectures have different sociocognitive underpinnings they possibly do not equally fit students with different learning styles. Research can provide evidence on how students' different backgrounds and learning styles may interact with the mode of presentation.

Conclusions

This study provides evidence that e-lectures can be safely used as students' introductory learning material to increase flexibility of learning, but only within a pedagogically limited perspective of learning as knowledge acquisition (as opposed to construction). It also highlights the fact that the availability of the e-lecture in combination with the spatiotemporal separation between study and review activities results in a lower level of teacher-student dialogue, which nevertheless did not influence the students' post-test performance.

Based on our experience, we argue that the adoption of e-lectures should be explored in close relationship to promising models of course/session re-engineering that (a) foster instructional cohesiveness by integrating the various learners' options as interconnected nodes of a productive learning network, and (b) efficiently match the attributes of the used media to the sociocognitive conditions favorable to any specific learning activity.

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Appendix

Post-test questionnaire

1. Do you agree with the opinion that lossy image compression happens when the Discrete Cosine Transformation (DCT) is applied on the original digital image signal? Yes or no and why?
2. Do you think that it is possible to have a compression scheme that applies first an entropy compression algorithm (like RLE) on the digital data to be followed by DC transformation? Yes or no and why?
3. In your opinion, do the higher or the lower values of the DCT coefficients indicate higher compression of the image? Why?
4. Describe a technique to vary the compression level when applying the JPEG scheme (what should be varied in order to achieve lower or higher compression?)
5. If the DC transformation of a digital image results in high values for the coefficients of the higher order frequencies, what does this imply for the visual information of the image file?

Wong, S. L., & Hanafi, A. (2007). Gender Differences in Attitudes towards Information Technology among Malaysian Student Teachers: A Case Study at Universiti Putra Malaysia. *Educational Technology & Society*, 10 (2), 158-169.

Gender Differences in Attitudes towards Information Technology among Malaysian Student Teachers: A Case Study at Universiti Putra Malaysia

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ABSTRACT

This article presents a quantitative study on gender differences in attitudes toward the usage of Information Technology (IT) related tools and applications. The study was conducted at Universiti Putra Malaysia, Malaysia, with 73 female and 29 male student teachers involved as participants. They were each presented with a questionnaire to relate their attitudes toward IT before and after undergoing a discrete IT course for the duration of one semester (14 weeks). The attitudes of the respondents were measured in terms of three dimensions, namely, usefulness, confidence and aversion. There were no significant differences between female and male student teachers when the pre- and post-test mean scores were compared. Both genders exhibited the same levels of attitudes before and after undergoing the comprehensive IT course. This suggests that the exposure to IT did not contribute to any significant gender disparity. The paired sample *t*-test results showed improved attitudes toward IT usage in both females and males after the exposure to IT. The biggest improvement for both females and males was in the aversion dimension which showed that their initial strong dislike toward IT was greatly reduced at the end of the course. In terms of confidence, female participants exhibited an enhanced confidence level after the course as opposed to the male participants. The results support the view that computer experience is gender-based as the increase in IT confidence over time assumed different patterns for females and males.

Keywords

Gender differences, IT attitudes, Student teachers

Introduction

Malaysia is one of the fastest developing nations in South-East Asia. Indeed, she has a national ambition, named Vision 2020, to attain developed-nation status by the year 2020 (Mohammad, 1998). Achieving Vision 2020 would be a big step towards Malaysia's success and achievement internationally. Various national policies have been formulated by the Malaysian government in its blueprint to achieve Vision 2020, one of which was known as the Smart School Policy and was designed to introduce Information Technology (IT) into mainstream education. It was introduced as one of the specific responses to Malaysia's need to make the critical transition from an industrial-based economy to a knowledge-based society (Mohammad, 1998).

The main thrust of the Smart School Policy is that by the year 2010, more than 10,000 of Malaysia's primary and secondary schools will be Smart Schools (Smart School Project Team, 1997). The Smart School Project Team (1997) has defined the Malaysian Smart School as a learning institution "…reinvented in terms of teaching-learning practices and school management in order to prepare children for the Information Age…" (p.20). All teachers will by then be expected to have the ability to use IT tools and applications in the teaching and learning processes. They are now expected to progressively adapt themselves from being knowledge presenters to knowledge facilitators in the IT based classroom. As knowledge facilitators, teachers will have new roles to play that are different from the conventional classroom teaching practices that they were used to (Shelley, Cashman, Gunter & Gunter, 2004). As Lai (1993) pointed out, apart from the role of teachers, they have to assume the roles of planners and managers, participants and guides (Lai, 1993). In Lai's view, as planners and managers, teachers will have to plan when setting up a computer-supported learning environment and will have to know how computer software can be integrated into existing school curricula. Lai (1993) also added that teachers will no longer be knowledge authorities but instead, will have to learn alongside the students. In addition, teachers must also be able to guide students to acquire metacognitive knowledge and higher level thinking skills in their knowledge construction.

As IT becomes more ubiquitous in our everyday lives, educational settings are being transformed where educators and students are expected to teach and learn, using the technology (Li, Kirkup & Hodgson, 2001; Lee, 2003). Educational institutions around the world are beginning to recognise the potential of IT in pedagogy (Oblinger & Rush, 1997). Introductory IT courses are compulsory for first year students in most of the institutions of higher learning around the world where students are taught to integrate IT tools and applications into their own learning process. Instructors are also encouraged to integrate IT into their teaching process to complement the integration of IT into the learning process. With the widespread influence of IT in education, the issues of gender differences in its use, access and attitudes have emerged and have attracted keen interest among researchers. Broos (2005), for example, pointed out that the growing importance of IT in diverse sectors of society has led to social divisions and gender discrepancy is one of such problems.

Research Background

The issue of the gender gap in IT has caught the attention of many researchers and as a result, numerous studies have been conducted to study the extent of this gap (Margolis & Fisher, 2002). As early as the 1980s, studies had reported that females exhibited more negative views and perceptions towards the use of computers than males (Dambrot, Watkins-Malek, Silling, Marshall & Garver, 1985; Koohang, 1987). Studies reported in the literature over 20 years ago suggested that gender has had a mediating effect on attitudes and perceptions towards IT but it is important to note that IT was an adequate term then when computers were mostly used for mathematical and word processing tasks but today, computers are being used in various facets of life (Mitra, Lenzmeier, Steffenmeirer, Avon, Qu & Hazen, 2000). The integration of computers and IT into the education system have greatly influenced the mindset towards IT. Hence, although the literature shows that extensive research related to gender and attitudes towards IT has been carried out over the years, such findings may be irrelevant today because of the ever expanding nature of IT.

The debate over the gender gap that started since the 1980s still persists in the new millennium. Many researchers have revisited this issue and many are continuing to do so. For example, the study by Houtz and Gupta (2001) found significant gender differences in the way females and males rated themselves in their ability to master technology skills. Even though both genders were positive about their technological ability, males rated themselves higher than females. In another study, Shashaani and Khalili (2001) reported that female undergraduate students had significantly lower confidence than males when it came to their ability to use computers. Females also reported feeling helpless, nervous and uncomfortable around computers. Both genders, however, viewed computers as a useful tool and equally believed that computers had positive effects on individuals and society. Tsai, Lin and Tsai (2001) reported similar results in their study which showed no significant gender differences in the perceived usefulness of the Internet.

Consistent with earlier studies (Houtz & Gupta, 2001; Shashaani & Khalili, 2001; Margolis & Fisher, 2002), a recent study by Broos (2005) also found significant gender differences – favouring males in terms of attitudes toward new communications technology, the extent of computer use and self-perceived computer experience. Even when females perceived themselves as being more competent in using computers, they expressed higher computer anxiety levels compared to males. This is not surprising as Liaw's study (2002) had also indicated that males had more positive perceptions towards computers and Web technologies than females.

Although they may not provide conclusive evidence of specific gender disparity, all the abovementioned studies, which were carried out among high school or undergraduate students except for Broos (2005), indicated that gender disparity in the use of IT for educational purposes existed to a certain extent. This is definitely a cause for concern as IT is considered a crucial tool for effective teaching and learning in most curricula.

The debate on gender disparity in IT has also been documented by several researchers who recognised the importance of other variables, such as students' computer experiences, socioeconomic status and age, in explaining gender differences. In the case of students' computer experience, Chen (1985) found that females and males responded with similar levels of interest toward computers when they possessed similar amounts of computer experience. Shashaani (1997) provided further evidence that computer attitudes and related experience were reciprocally related. Shashaani (1997) revealed that students who were more knowledgeable in computers had used computers more frequently and had greater access to home computers. They were also more interested in computers and had more confidence working with them. This suggests that the discrepancy between male and female attitudes can be reduced to a certain extent if computer experience is controlled (Shashaani, 1994a; 1997). Kirkpatrick and Cuban (1998) noted that the gender gap was narrowed when both genders were exposed to the same amounts and types of experiences when using computers. On the contrary, Kadijevich's (2000) study found that males exhibited more positive attitudes toward computers than females even when computer experience was controlled. This means that such experience does not necessarily have a mediating effect on computer attitudes.

Most of the early studies revealed that computer experience played a role in narrowing the gender gap while other studies indicated that such experience might be gender-based. Broos (2005), for instance, found that prior computer experience would only have a positive effect for males. More experienced male users showed greater positive attitudes toward IT while females with equal computer experience reported having computer anxiety. Todman (2000), on the other hand, found that the reduction in computer anxiety for males was more apparent over time than in the case of females.

Similarly, socioeconomic status and age are also important variables to consider. Shashaani (1994b) found that socioeconomic status, as indicated by parents' occupations and incomes, had a significant influence on students' attitude towards computers. Students from families with higher socioeconomic status were found to have more positive computer attitudes than those from families with lower status (Shashaani & Khalili, 2001). It can be assumed that those from the higher socioeconomic end are more likely to have a computer at home or have better opportunities of gaining access to one. In terms of age, studies have also found gender differences in attitudes in younger individuals and the differences increase among older individuals (Kirkpatrick & Cuban, 1998; Jennings & Onwuegbuzie, 2001). These studies are, however, inconsistent with the study by Lau and Ang (1998) and Roussos (2007) who found that age had no significant relationship with attitudes towards computing.

Purpose of Study

The rapid IT developments in the Malaysian education system in the past decade, especially the implementation of Smart Schools, have influenced expectations from higher institutions in Malaysia. These institutions are expected to train and equip graduate teachers with adequate knowledge and skills to utilise IT as an effective tool in their teaching practices. Teachers are also expected to possess the right attitudes towards the usage of IT. Mitra et al. (2000) stressed that the aspect of gender has remained relatively constant as an independent variable in determining the levels of learning, attitudes and the use of computers. In fact, a review of existing literature reveals that gender disparity in attitudes still exists among undergraduate students in higher institutions of learning. Premised on this assumption, the present study was conducted to examine gender differences in attitudes among student teachers at Universiti Putra Malaysia (UPM), Malaysia. As prior research has also shown that experience in using IT can influence attitudes toward the usage of IT, this study also assumed that there would be a significant difference in such attitudes of student teachers before and after their completion of a discrete IT course. In this study, the following research questions were investigated:

1. Are there gender differences in attitudes towards IT among the student teachers before their enrolment in the discrete IT course?
2. Are there gender differences in attitudes towards IT among the student teachers after their enrolment in the discrete IT course?
3. Are there differences in attitudes towards IT for the female student teachers before and after their enrolment in the discrete IT course?
4. Are there differences in attitudes towards IT for the male student teachers before and after their enrolment in the discrete IT course?

Methodology

Subjects and procedures

There were 102 participants in this study (73 females and 29 males) from three intact student groups from the Faculty of Educational Studies, UPM. These students were registered for a compulsory discrete IT course. Their ages ranged from 19 to 30 years old (M= 21.06 years; SD= 1.86 years). The female students had an average of 1.81 years of computer experience (maximum computer experience= 9 years; S.D.= 0.23 year) while their male counterparts had an average of 1.60 years of experience (maximum computer experience= 7 years; S.E.= 0.36 year) prior to their enrolment in the discrete IT course. The mean ages of females and males were 20.81 (SD=1.32) years old and 21.72 (SD=2.74) year olds respectively. All these students majored in education and were predominantly from middle-class income families.

The enrolment in the discrete IT course − Information Technology in Education (EDU 3033) − which was introductory in nature, was compulsory for all participants in the survey. This course was facilitated by a female instructor who met with the students for three hours a week for fourteen weeks in a computer laboratory. In addition, the students were also given a two-hour lecture each week by a course instructor who introduced the fundamentals of each IT tool and application via a laptop computer. The laptop display was projected onto a big screen at the front of the lecture hall to enable all the students to view every aspect of the instructor's display. The laboratory sessions, on the other hand, comprised hands-on instructions and several projects to be completed by the students. The projects consisted of assignments and hands-on exercises in word processing, presentations, databases, spreadsheets and homepages. Only the assignments were graded.

The first set of questionnaires was administered to the students on the first day of the course (Time 1) while the second identical set was administered on the final day (Time 2) of the course. The duration between Time 1 and Time 2 was one semester (14 weeks). The two questionnaires generated a matched pair of data for each student. This was done to determine the effect of exposure on the attitudes towards IT among the student teachers.

Instrumentation

Two sets of identical questionnaires were developed in the Malay language. The English version of the questionnaire is shown in Appendix A. The questionnaire used was adapted from Wong (2002) and it measures the attitudes of participants towards IT. Several items in Wong's (2002) study were adapted from Christensen and Knezek (1998) and Loyld and Gressard (1984). Three dimensions were measured, these being usefulness, confidence and aversion. Wong (2002) and Davis (1989) defined usefulness as the student teachers' beliefs in the enhancement of the quality of their academic or non-academic related work by using a specific system. Confidence and aversion were defined as the student teachers' feelings of uncertainty and strong dislike respectively in using the Internet, specific software applications, other general software applications as well as the computer and IT in general for leisure or academic work respectively (Wong, 2002).

The questionnaire comprised 23 items and each item was accompanied by a Likert scale ranging from a score of 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree" for positive items (and vice versa for negative items). The questionnaire was validated by an independent course instructor. The questionnaire was pilot tested on a group of students (N= 29) who took the same course a semester before this study was conducted. No ambiguous items were found and the reliability for the 23 items was established at .87 using the Cronbach alpha, indicating good internal consistency.

Data analysis

An independent *t*-test was conducted to determine if there was any significant difference between females and males in terms of their prior computer experience before taking the EDU 3033 course. A one-way between-group multivariate analysis of variance (MANOVA) was performed on the pre- and post- test scores separately to examine if mean differences were significant between females and males in terms of usefulness, confidence and aversion before and after completing the course. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices and multicollinearity. No serious violations were noted in any of the test scores. Analyses of variances (ANOVA) on each dependent variable were conducted as follow-up tests to the MANOVA. Using the Bonferroni method, each ANOVA was tested at the adjusted alpha level of .003. It is important to note that the alpha levels reported for confidence and aversion were the cumulative sum of the separate alpha levels for both as these two variables have reciprocal effects and are, thus not considered mutually exclusive of each other. A paired-sample *t*-test was conducted and tested at the .05 level to evaluate if there was any significant difference between scores from Time 1 and Time 2 in respect of the three dependent variables. The analysis was conducted separately for both females and males, to examine if female and male students' attitudes were more positive after completing the EDU 3033 course.

Results

The independent *t*-test did not yield any significant difference between the mean scores of the female (M= 1.81; SD= 1.96; S.E.=0.23) and those of the male respondents [M=1.60; SD= 1.91; S.E.=0.36; t(100)= .485, p= .628] in respect of their prior computer experience. This suggests that both genders had almost equal prior computer experience before enrolling in EDU 3033.

Pre-test Gender Differences

Based on MANOVA, the pre-test mean scores did not show any statistical significant difference between females and males on the combined dependent variables (usefulness, confidence and aversion): $F(3,98)= .259$, $P= .855$; Wilks' Lambda= 0.992, partial eta squared= 0.008. This means that none of the three dependent variables reached a statistical significance even though female participants recorded slightly higher mean scores than male participants in these variables.

Table 1: Pre-test Differences between Females and Males

	Females		Males				
Dependent variables	Mean	S.D.	Mean	S.D.	F	*p*	Partial Eta Squared
Usefulness	38.81	4.48	38.75	5.07	.002	.961	.000
Confidence	23.70	3.52	23.66	4.43	.003	.958	.000
#Aversion	26.32	2.73	25.80	3.59	.631	.429	.006

#A high score represents low aversion
*significant at $p<.003$

Post-test Gender Differences

The post-test mean scores also did not show any statistical significant difference between female and male participants on the combined dependent variables: $F(3,98)= .259$, $P= .992$; Wilks' Lambda= 0.999, partial eta squared= 0.001. No significant differences were found between the mean scores of the females and the males in respect of the three variables (usefulness, confidence and aversion towards IT) after completion of the EDU 3033 course.

Table 2: Post-test Differences between Females and Males

	Females		Males				
Dependent variables	Mean	S.D.	Mean	S.D.	F	*p*	Partial Eta Squared
Usefulness	42.77	4.46	42.55	4.49	.048	.826	.000
Confidence	25.23	5.58	24.90	4.77	.082	.776	.001
#Aversion	42.86	8.15	42.52	9.07	.030	.863	.000

#A high score represents low aversion
*significant at $p<.003$

Effects of the EDU 3033 Course on Gender

Two paired sample *t*-test were conducted to examine the effect of one semester of the EDU 3033 course on female and male student teachers' attitudes toward IT. The results showed significant differences in the three dimensions of attitudes towards IT for females but only in two dimensions for males (Table 3).

For females, there was a statistically significant difference between the mean scores from Time 1 (M= 38.81; S.D.= 4.48) and Time 2 (M= 42.77; S.D.= 4.45), $t(72)$= -7.196, p<.0005 for usefulness. The analysis also found a statistical difference between the mean scores from Time 1 (M= 23.70; S.D.= 3.52) and Time 2 (M= 25.23; S.D.= 5.58), $t(72)$= -2.545 , p=.013 for confidence as well as the mean scores from Time 1 (M= 26.32; S.D.= 2.73) and Time 2 (M= 42.84; S.D.= 8.15), $t(72)$= -18.885, p<.0005 for aversion.

For males, a statistically significant difference was detected between the mean scores from Time 1 (M= 38.76; S.D.= 5.07) and Time 2 (M= 42.55; S.D.= 4.48), $t(28)$= -4.462, p<.0005 for usefulness as well as the mean scores from Time 1 (M= 25.80; S.D. = 3.59) and Time 2 (M= 42.52; S.D.= 9.07), $t(28)$= -10.820, p<.0005 for aversion. However, no statistical difference was detected between the mean scores from Time 1 (M= 23.66; S.D.= 4.43) and Time 2 (M= 24.90; S.D.= 4.76), $t(28)$= -1.415 , p=.168 for confidence.

Table 3: Mean Difference between Pre- and Post-tests

Subscale	Pre-test		Post-test		t	P
	M	*S.D.*	*M*	*S.D.*		
			Females (n=73)			
Usefulness	38.81	4.48	42.77	4.45	-7.20*	.000
Confidence	23.70	3.52	25.23	5.58	-2.55*	.013
Aversion	26.32	2.73	42.84	8.15	-18.89*	.000
			Males (n=29)			
Usefulness	38.76	5.07	42.55	4.48	-4.46*	.000
Confidence	23.66	4.43	24.90	4.76	-1.42	.168
Aversion	25.80	3.59	42.52	9.07	-10.82*	.000

*significant at p<.005

Discussion

The results of this study do not support the assumption that there are significant gender differences in the attitudes of student teachers at UPM towards IT. This is because no significant difference in attitudes was detected between females and males before their enrolment in the EDU 3033 course. The results suggest that gender disparity does not exist even though the student teachers had no formal exposure to IT prior to taking the course. Perhaps this was because they possessed almost equal prior computer experience before their enrolment in the course, with most of them having at least one year of relevant experience. This is evident from the earlier *t*-test conducted where no significant difference was detected between females and males in terms of their prior computer experience measured in years. It is important to note that these student teachers' prior computer experiences were primarily acquired informally through the existence of computer clubs in most Malaysian schools. It is therefore very likely that they were exposed only to the basics of word processing software in such an informal learning environment. It is also unlikely that they acquired their computer experience from the home because most of the participants shared almost the same social background where the availability of home computers was limited.

In Malaysian lower secondary schools, the subject "Computer in Education" has been introduced over the last four years as a non-examination subject and these schools are equipped with adequate computer facilities to teach this subject to their students. Generally, almost all secondary schools in Malaysia have at least one computer laboratory equipped with a minimum of 15 personal computers. Lower secondary students are exposed to the fundamentals of productivity tools for at least 40 minutes per week. Most of the teachers conducting this laboratory class have no formal prior training on the use of IT related tools and applications. They have been exposed only to the in-service courses conducted by relevant authorities. This means that the student teachers who participated in this study did not receive any formal IT training while in school.

Likewise, no significant difference in attitude was detected between females and males after the completion of the EDU 3033 course. This suggests that exposure to the IT course had no effect on gender disparity between females and males. Interestingly, even after gaining more IT knowledge and using it increasingly for academic and non-academic purposes, both females and males participants showed equal interest in the subject. They agreed that IT was useful to them because the productivity tools, such as word processing, spreadsheets and database software applications, could enhance and improve the quality of their academic work and presentation. They also had a positive impression of Internet technology as it has the ability to improve their communication skills with peers for personal or educational purposes.

The results of the first MANOVA analysis did not indicate any apparent gender disparity between the female and male student teachers despite their limited knowledge on IT prior to pursuing a degree programme at UPM. The results of the MANOVA analysis also did not indicate any apparent gender difference after both females and males have been exposed to a formal IT training course. This suggests that both genders acquired almost the same levels of knowledge and skill and had similar attitudes and perceptions towards the use of IT tools and applications. These results concurred well with those of Chen (1985) who found that both females and males, with almost equal amounts of computer experience, responded similarly to computer exposure. The results of this study are, however, contradictory to the findings of Houtz and Gupta (2001), Shashaani and Khalili (2001) and Broos (2005) which found that females and males differed significantly in many ways in terms of IT related matters. However, caution is called for when comparing the results of this study with that of the earlier studies because of the different methods and instruments used. A definitive conclusion cannot be made unless the same instruments and methods are utilised each time.

The paired sample *t*-test results showed that at the end of the course, both females and males expressed enhanced positive attitudes and less negative attitudes towards IT usage. The biggest difference for both females and males was in the aversion dimension which showed that the magnitude of their strong dislike toward IT was greatly reduced at the end of the course. At this stage, both genders also agreed more strongly that IT was useful for them. They were also more inclined to agree that IT was valuable to them as students primarily due to the enhancement in the quality of their academic work. However, only females exhibited significantly more confidence in IT at the end of the course. This is surprising as earlier studies by Houtz and Gupta (2001) and Shashaani and Khalili (2001) showed otherwise with females exhibiting lower confidence than males in their ability and confidence to use computers. The higher confidence level exhibited by females in this study could be due to the age difference. In this study, female participants were slightly younger than their male counterparts. Age could have played a role in enhancing confidence among the younger female participants (Kirkpatrick & Cuban, 1998; Jennings & Onwuegbuzie, 2001). Another possibility could be the effect of the role model. The instructor for this course was a female instructor and her presence during the entire duration of the course could have increased the female students' confidence level.

With the exception of the confidence dimension, the results of this study also support the argument that IT experience gained from undergoing a course can improve the attitudes of both genders towards computers. The students were more skilful and knowledgeable at the end of the course. The findings also support the view that computer experience is gender-based as the increase in IT confidence over time assumed different patterns for females and males. In other words, gender interacts indirectly with computer experience by influencing IT confidence. The results run parallel to the findings of Broos (2005) and Todman (2000) which found that such experience could help reduce the anxiety level of males more than that of females.

Limitations of Study

It should be noted that the ratio of females to males who participated in this study was unequal and the number of participants involved was relatively small (N=102). These factors could pose a threat to the results generated from the MANOVA analysis. Based on the recommendations by Pallant (2001), the number of cases in each cell should be more than the number of dependent variables. The minimum number of cases in each cell for this study was three (the number of dependent variables). In this study, the number of cases per cell far exceeded the minimum number of cases set.

The fact that there were many more females than males in the particular course was unavoidable. This is because there are more female than male undergraduate students at UPM at the ratio of 60:40. It would have been more appropriate if this study was to be based on a more balanced ratio of females to males. Future studies should consider using the stratified sampling method to get a more representative sample. It is also recommended that the sample size be increased for future studies.

It is important to note that this study was preliminary and exploratory in nature. All data collected was based entirely on the honesty and the perceptions of participants regarding their attitudes towards IT. A further limitation of this study was that it provided only a "snapshot" of the time when data was collected. It must also be recognised that the participants involved were undergraduate students majoring in education at a public university and had volunteered to participate in this study. Clearly, this was a self-selected group who might have possessed a different set of expectations compared to the general body of student teachers. Therefore, caution must be taken when generalising any findings for the entire population at the faculty where this study was conducted.

Conclusion

The findings of this research suggest that gender does not have an impact on the attitudes of female nor male student teachers towards IT when the same amount of exposure is given to both groups. These findings, however, would apply only when these student teachers possess equivalent level of IT experience and are homogenous in their background knowledge and skill prior the exposure as was the case in this research group. In other words, when the amount of IT experience is controlled, females and males respond equally in terms of attitude towards IT. When detailed dimensional analyses of attitude were conducted in terms of confidence, usefulness and aversion on the part of the students, the dimension of aversion recorded the biggest improvement which indicated that the magnitude of their strong dislike toward IT was greatly reduced at the end of the course. There was also a significant difference in the aversion and usefulness dimensions for both genders at the end of course, an indication that the course played a role towards improving the attitudinal measurement in these two dimensions. However, in respect of confidence, only female participants exhibited an enhanced confidence level. The confidence level of the males remained the same despite the exposure. In general, the results of this study suggest that there is no obvious gender disparity in the student teachers' attitude towards IT after an exposure to a comprehensive IT course. These student teachers have a very important role to play when they graduate and embark on their teaching profession in Malaysian schools. The relevant educational authorities, students and society at large can look forward to the future positively knowing that the teachers possess positive attitudes towards the use of IT in their instructional approaches regardless of their gender.

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Appendix A

A Survey on Attitudes towards Information Technology

Thank you for taking the time to complete this survey. Your responses will provide valuable insight into student-teachers' attitudes towards Information Technology. Please answer each question in the following three sections to the best of your ability.

Please complete all three sections by placing checkmarks in the appropriate boxes and filling in the blanks for written answers.

SECTION 1: Background
The purpose of this section is to collect some basic information about your background.

1.1 Age ____________years

1.2 Matriculation Number ____________

1.3 Gender ☐ Male ☐ Female

1.4 Do you have experience using computers? ☐ Yes (Please proceed to question 1.5) ☐ No (Please proceed to Section 2)

1.5 How many years have you been using computers? ____________years

SECTION 2: Attitudes toward Information Technology
The purpose of this section is to assess your attitudes towards Information Technology

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2.1	The use of electronic mail makes it easier to contact my friends.	☐	☐	☐	☐	☐
2.2	The Internet is useful when searching for information.	☐	☐	☐	☐	☐
2.3	Word processing software allows me to edit my work more frequently.	☐	☐	☐	☐	☐
2.4	My writing is of quality when I use word processing software.	☐	☐	☐	☐	☐
2.5	Database software makes it easier to manage information.	☐	☐	☐	☐	☐
2.6	Database software allows me to keep information systematically.	☐	☐	☐	☐	☐
2.7	My presentation is more effective when I use presentation software.	☐	☐	☐	☐	☐
2.8	My presentation is more interesting when I use presentation software.	☐	☐	☐	☐	☐
2.9	Spreadsheet software allows me to do calculations easily.	☐	☐	☐	☐	☐
2.10	Spreadsheet software allows me to create various charts easily.	☐	☐	☐	☐	☐
2.11	I feel that I will not master advance computer software skills.	☐	☐	☐	☐	☐

2.12	I feel that using a computer is difficult for me.	☐	☐	☐	☐	☐
2.13	The challenge of solving problems with computers does not appeal to me.	☐	☐	☐	☐	☐
2.14	I am not skilful in using a computer.	☐	☐	☐	☐	☐
2.15	I can get good grades in Information Technology courses.	☐	☐	☐	☐	☐
2.16	I have great confidence when attending Information Technology courses.	☐	☐	☐	☐	☐
2.17	I feel that I take a long time understanding some issues taught in Information Technology classes.	☐	☐	☐	☐	☐
2.18	Only intelligent people can use Information Technology.	☐	☐	☐	☐	☐
2.19	I will never take a job where I have to work with Information Technology.	☐	☐	☐	☐	☐
2.20	The use of information technology prevents me from being creative.	☐	☐	☐	☐	☐
2.21	Only people who are skilled should use Information Technology.	☐	☐	☐	☐	☐
2.22	Learning about Information Technology is a waste of my time.	☐	☐	☐	☐	☐
2.23	The time spent on learning Information Technology is better spent on learning something else.	☐	☐	☐	☐	☐

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'Hole-In-The-Wall' Computer Kiosks Foster Mathematics Achievement - A comparative study

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ABSTRACT

Earlier work at unsupervised playground computer kiosks in rural India, popularly called 'hole-in-the-wall', showed that children exposed to these kiosks learn to use computers on their own and that they are able to clear school examinations in computer science, without any classroom teaching for it. Extending this, our recent research work examines the possible impact on attainments in other curricular subjects, arising from self-directed use of these kiosks. This paper investigates the impact of use of the playground computer kiosk, on school examination results, of students in a rural school in India over a 2.5-year period from 2002-2004. A comparative study was conducted, of students from a kiosk school and a non-kiosk school, as well as of frequent and infrequent users of the kiosk. The study covered groups of a total of 161 students who were aged 13-14 in 2004. Students were measured for differences in their intelligence, creativity potential, leadership potential, and frequency of kiosk use. The school results show a significant impact of kiosk usage on Mathematics achievement.

Keywords

Hole-in-the-wall, Collaboration, Learning, Technology, Mathematics

Background

Seymour Papert's seminal book on computers in education titled - Mindstorms: Children, Computers and Powerful Ideas (1980) - presented frameworks for the use of computers in education. Later Papert spoke of stages in learning, as stages in the relationship between the individual and knowledge (1980s discussion between Papert & Freire). The three stages mentioned go from self-directed, experiential learning in early childhood to 'teaching' and 'being told' in school and comes back to experiential learning among creative adults. By providing exploratory opportunities of immense complexity, during the school years, technology brings self-directed, experiential learning back into the second, 'school' stage. In 1996, Papert saw the proliferation of personal computers in homes as a welcome change from computers in schools and described frameworks for using the computer as an educational tool within families (Papert 1996, interviewed by Bennahum). There appeared to be problems, according to Papert, with the deployment of computers in education. In school, computers were sent into computer labs and hijacked, so to speak, into the structure of school instructional curriculum, class timetables and a strict age-wise segregation.

The home environment, while providing possibilities for self-directed, experiential learning, does not offer as many social opportunities for interactive learning with others in peer groups.

In 1999, the 'hole-in-the wall' experiment in New Delhi, India, moved the computer out of schools and homes into playgrounds. A computer was connected to the Internet and embedded into a brick wall around an informal playground next to a residential slum. Slum children were able to use the computer to browse, play games, create documents and paint pictures within a few days (Frontline World 2002, Education Guardian 2000, Businessweek Online 2000, Mitra 2000, Mitra 2003 and Wullenweber 2001). Children aged 8-14 worked together in groups at the computer, making exploratory discoveries, generalizing their learning, describing it in a local context and teaching each other. The press called the experiment "hole-in-the-wall". Researchers called it "Minimally Invasive Education" (MIE). Research showed that groups of children could learn how to use public computers on their own, without adult intervention (e.g. Mitra and Rana 2001; Mitra 2003; Inamdar 2004).

The delivery mechanism for MIE uses 'hole-in-the-wall' kiosks with computers embedded in holes in the outer walls of a hut like structures, the monitor screens facing outside. Presently (November 2005) there are over 105 computers deployed through Minimally Invasive Education kiosks (MIE kiosk) in rural and urban India. An estimated 40,000 children have used these kiosks. The kiosks are placed in playgrounds and are not supervised by teaching staff.

The computer has been a 'material' for constructionist learning (Papert 1980's) in classrooms and homes. Moving it to playgrounds marks a change in the way it has been used, and hence its potential, possible impact. In this paper we examine the impact of playground MIE kiosks on achievement in school examinations. A significant impact is found on results in the subject of Mathematics.

A Hypothesis for the present study

MIE kiosks were set up in the villages of Sindhudurg district of Maharashtra State in India, in April 2002 (see photo 1). The kiosks are placed in playgrounds or close to schools.

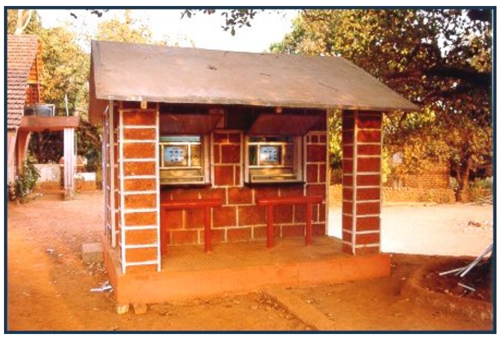

Photo 1. MIE kiosk, Kalse Village, Sindhudurg District, India

Each kiosk in the Sindhudurg district houses 2 computers and incorporates special design features to allow for public access, tropical conditions, remote monitoring, and usage by children (Inamdar 2004). The computers in the MIE kiosks offer an English language Microsoft Windows environment. Three kiosks were connected to the Internet via VSAT in June 2004. Offline content on the kiosk computers includes both educational games and videos, as shown in table 1.

Table 1. Off-line educational material on computers at MIE kiosks

	Mathematics	English	Science	Total
Educational Games	8	8	5	21
Educational videos	21	2	15	38

Educational games installed on the computers were free downloads from the Internet. The educational videos were provided by an Indian educational agency.

The Mathematics games covered activities related to learning numbers, shapes, sizes, quantities, patterns, basic addition, subtraction, division, multiplication, and basic algebra (translating word problems into solvable equations).

Games for English language learning included learning the alphabet, letter sounds, spelling, common English words and phrases, rhyming words, adjectives and word families.

Science games included content on electricity, time, space, gravity, kinetics, continents, oceans, animals and deserts.

The local language as well as the language of instruction in the village schools is Marathi. English is learned as a second language from Grade 1.

Rural children aged 8-14 use these kiosks in groups in a process characterized by collaboration, discovery and knowledge construction. Adults do not supervise the kiosks and there is no formal coaching/teaching. A study of the impact of the kiosks on school achievement in the computer science subject showed that children who had learned computers on their own at the MIE kiosk were able to clear the Grade VIII computer science examination without being taught the subject during the school year (Inamdar, 2004). The study also describes group based self-learning patterns at the kiosks. Learning did happen in the school subject of computer science. Could the kiosk impact learning in other academic areas?

The primary method of evaluation in Indian schools is examinations that are conducted twice during the school year. We investigate if learning at the MIE kiosks shows up as improved performance in these examinations in the subjects of English, Science and Mathematics. The following are hypotheses for our research:

1. If given appropriate access, connectivity and content, groups of children can learn to use computers and the Internet to achieve a specified set of the objectives of education, with none or minimal intervention from adults.
2. Academic/School performance will be impacted by the frequency of use of the MIE kiosk.

In this paper we analyze the impact of the kiosk on objectives of education as measured by performance in school examinations.

Method

Villages Shirgao and Kuvle, of the Sindhudurg District, are at a half hour driving distance from each other. The Shirgao School has an MIE kiosk in the school playground. Kuvle has no computers at all. All of 161 children aged 13-14 in 2004, from both villages, were included in our study. Scores on school examinations in the subjects of English, Science and Mathematics were chosen as the dependent variables observed for the impact of the kiosk.

As mentioned, field observations at MIE kiosks show that the learning process at MIE kiosks involves random exploration, collaboration and discovery. Factors of intelligence and personality could play a role in these processes. Hence tests for intelligence and personality tests for creativity and leadership were conducted on all students. The intention was two-fold - to check for any differences between the two villages, before the kiosk, on variables of personality and intelligence and to check for differences between the two villages on the dependant variable – scores in school examinations.

Since kiosk usage is voluntary it was necessary to know the kiosk usage patterns of the group at Shirgao. Hence, a second level comparison was conducted of frequent and infrequent users of the kiosk within the Shirgao population. Therefore, the two levels of comparison conducted were as follows:

1. Between kiosk village (Shirgao) vs. non-kiosk village (Kuvle)
2. Between frequent kiosk users vs. infrequent kiosk users within Shirgao

The comparison of villages could tell us of differences, if any, due to intelligence and personality factors impacting school scores. Data from Shirgao could provide a reference point for understanding differences, if any, between frequent and infrequent users within the kiosk village population. Additionally, the two levels of comparison could provide us useful information on another independent variable that could critically affect school scores – school coaching quality. Differences in scores for comparable groups between villages could point to changes in school coaching quality and/or MIE kiosk. Clearly, this factor of school quality would apply equally to frequent and infrequent users of the kiosk from the same school (Shirgao), and serve as a crosscheck.

The following tests were conducted on a population of 116 schoolchildren from Shirgao and 45 from Kuvle:

1. Test for Intelligence - Raven's Standard Progressive Matrices (SPMRS)
2. Test for personality - Catell's High School Personality Questionnaire. The composite scores on leadership potential (LP) and creativity potential (CP) were considered
3. Test for kiosk usage – Frequency of Usage Test (FUT).

While the first two tests are standardized and well known, the third test was devised for the specific needs of this research project. Its design is elaborated under the heading 'The Frequency of Usage test' below.

School examination scores (Mathematics, Science, English) of the 161 children were collected from the time before MIE kiosk implementation – March 2002 – and 2.5 years after – October 2004.

The method of analysis of variance (ANOVA) was used to examine differences between categories of data. The differences were regarded significant if $P < 0.05$ and highly significant if $P < 0.01$.

The Frequency of Usage Test (FUT):

The Frequency of Usage Test (FUT) was devised by one of the authors of this paper (Inamdar) to arrive at an empirical measure of that independent variable - individual's frequency of MIE kiosk usage. The FUT is a one-page questionnaire that yields a self-report as well as a peer report of an individual's frequency of kiosk usage. This method of arriving at a consensus-based judgment of an observable behavior is not unknown in human personality research (see Box 1).

Consensus-based judgment

A significant body of research on human personality judgment has established the method of consensus between self and peer reports for making human personality judgment. These studies suppose that if personality differences can be observed then there should be a consensus among independent observers on the relative standing of the observed person on personality traits. The personality judgment approach as described by Funder in 1999 centered on judgments of individuals by knowledgeable informants. In 1994 Hofstee stated "The averaged judgment by knowledgeable others provides the best available point of reference for both the definition of personality structure in general and for assessing someone's personality in particular". In a validation of the five factor model of personality McCrae and Costa (1987) used two data sources - self reports and peer reports – to validate the 5-factor model of personality. Studies typically show interobserver agreement correlations in the region of .50 (e.g., Funder, Kolar, & Blackman, 1995; McCrae, 1982). Further, personality studies extended to dogs personality have used this approach and have shown human owner to peer correlations for owner personality judgments at .55 and for the dog personality judgments at .62 (Gosling, Kwan, & John2003). Judgments by knowledgeable others is considered an acceptable method.

Box 1

Each individual in a group of 6 peers was administered a one page questionnaire wherein s/he indicated his/her peers' frequency of kiosk usage as well as his/her own. One of the following options were indicated by each student, for each student:

1. Never visit
2. Visit once in a fortnight
3. Visit one to three times in a week
4. Visit four to seven times in a week

This means there were 6 scores to be analyzed for each individual. The mode value was taken as the indicator for frequency of the individuals kiosk usage. It represents the score reported by the largest number of students within the group. In other words, this is the judgment of the majority of students. It does not rule out the extreme values within the group if the Mode is at these values.

The first two categories listed above were combined in the results to define *infrequent users*. Categories 3 & 4 were combined to define *frequent users*. Correlations between peer and self-reports were at 0.61, an acceptable confidence level, as shown by prior work on judgments by consensus.

Results

Differences between two villages in CP, LP and SPMRS scores

To begin, we attempt a comparison between the two village groups of Shirgao & Kuvle on Leadership Potential (LP), Creativity Potential (CP) and Standard Progressive Matrices Raw Score (SPMRS).

Table 2 below shows differences between Shirgao and Kuvle in averages for personality tests. Analysis of Variance (ANOVA) shows no significant difference between Shirgao and Kuvle on average scores of LP, CP or SPMRS. This indicates that the populations of Shirgao and Kuvle are matched on leadership potential, creativity potential and intelligence.

Table 2. Differences between Villages in Averages for Personality Tests

		N	Average	Difference*
CP	Shirgao	116	6.58	
	Kuvle	45	6.31	-0.28
	Total	161	6.51	
LP	Shirgao	116	4.98	
	Kuvle	45	5.74	0.76
	Total	161	5.19	
SPMRS	Shirgao	116	32.51	
	Kuvle	45	35.69	3.18
	Total	161	33.40	

*None of the differences is significant

Differences between two villages in school examination scores

Figure 1 shows the average school scores for English, Mathematics and Science for Shirgao and Kuvle in March 2002, *before the MIE kiosk was setup in Shirgao*. ANOVA shows no significant difference in the average scores of English, Mathematics and Science between the two villages - we could say that both villages well matched.

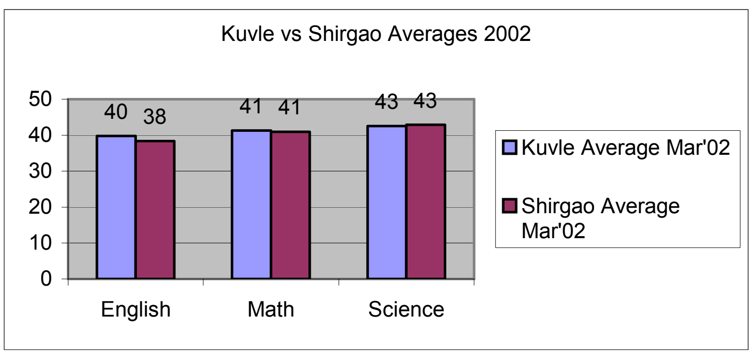

Figure 1. Average school scores for Shirgao and Kuvle

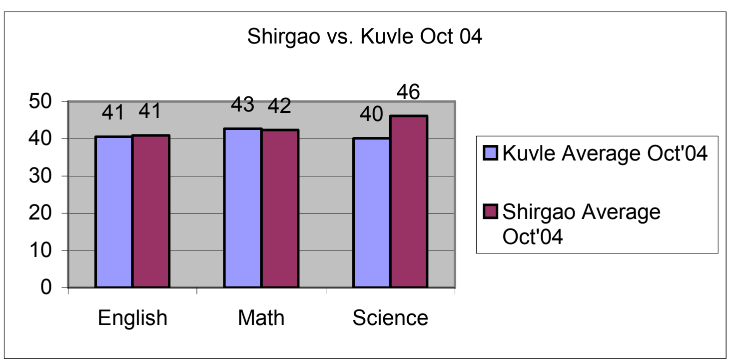

Figure 2. Average school scores for both villages

Figure 2 shows the average school scores for English, Mathematics and Science for both villages in October 2004, 2.5 years after the MIE kiosk setup in Shirgao. ANOVA shows no significant difference between the two villages on average scores for English and Mathematics. However the Science score at Shirgao is significantly higher than Kuvle. Since both village groups are matched on LP, CP and SPMRS, the other factors of school coaching and/or MIE kiosk could account for the higher scores in Shirgao in Science in October 2004.

It could appear that Shirgao's scores in Science are significantly higher than Kuvle's scores in Science in October 2004 due to the presence of the kiosks. However factors related to school quality could have impacted this change too. A more in-depth look within the Shirgao population is undertaken.

Differences between Shirgao frequent and infrequent users in CP, LP & SPMRS scores

The assumption is that all students at Shirgao are exposed equally to the same school-related factors – resources, quality of teaching and evaluation. Therefore, to analyze the effect of the kiosk on school scores we checked for differences between frequent and infrequent users. The FUT indicated that of the total of 116 children tested in Shirgao, there were 62 frequent users and 54 infrequent users. These two groups in Shirgao were compared on the following factors:

1. Creativity potential (CP)
2. Leadership potential (LP)
3. Standard Progressive Matrices Raw score (SPMRS)
4. School scores – Science, Mathematics English

Table 3 shows that ANOVA found no significant differences between frequent and infrequent users on average LP and CP scores. There is, however, a significant difference between the two groups on average intelligence scores. Therefore the factors of CP and LP are ruled out as affecting differences in school scores of frequent and infrequent users. However it does leave intelligence to be considered.

Table 3. Differences Among Frequency Groups in Shirgao for Personality Tests

		N	Average	Difference
CP	Infrequent Visitors	54	6.53	
	Frequent Visitors	62	6.63	0.10
	Total	116	6.58	
LP	Infrequent Visitors	54	5.01	
	Frequent Visitors	62	4.94	-0.07
	Total	116	4.98	
SPMRS	Infrequent Visitors	54	29.07	
	Frequent Visitors	62	35.50	6.43
	Total	116	32.51	

Differences for SPMRS are significant ($P < 0.05$), but not for CP and LP

Further Method

At this juncture, we could hypothesize that the different SPMRS scores of frequent and infrequent users as well as the frequency of kiosk usage could account for any difference in school subject scores between the two groups. However, any differences in school scores seen between user groups due to the intelligence factor should remain stable over time – before kiosk and after kiosk.

To check for the impact of the kiosk, as distinct from school coaching related factors and SPMRS, we adopt the following approach:

1. Determine value of difference between frequent and infrequent user groups before the kiosk in March 2002. Is the difference significant?
2. Determine value of difference between frequent and infrequent user groups after the kiosk in October 2004. Is the difference significant?

3. Determine the value of change in the differences before (March 2002) and after (October 2004). Is the change in differences significant?

We expect that the *significance of change* in differences between the two users groups over the years should isolate the influence of MIE kiosk usage on school scores, from the influence of school coaching related factors or SPMRS.

Differences between Shirgao frequent and infrequent users in school English results

Table 4 shows ANOVA results that frequent user average scores in English are higher than infrequent users in March 2002. However, this difference in scores in March 2002 is not statistically significant. Again, the differences in English scores between the two groups in October 2004 are positive but not significant. More importantly, there is *no significant change in the differences* between March 2002 and October 2004. *Therefore there appears to be no significant influence of the kiosk on English scores.*

It is useful to recall that there are no significant differences between the villages Kuvle and Shirgao in English before or after the kiosk set up (figure 1 & figure 2). This data seems to indicate that the present MIE kiosk, with the present off-line content has not significantly impacted English scores at Shirgao.

Table 4. English ANOVA Differences

	Differences March 2002	Differences October 2004	Change of Difference from March 2002 to October 2004
Frequent – Infrequent	3.21	4.49	1.28

Neither of the differences nor the change in differences is significant

Differences between Shirgao frequent and infrequent users in school Science results

Curiously, table 5 ANOVA results below show a significant difference between the frequent and infrequent user groups in Science both before and after the kiosk was set up. This is clearly impacted by factors other than use of kiosk, though not necessarily in entirety. Our data shows that frequent users have higher average intelligence. This may have impacted the difference in science scores before the kiosk (March 2002).

There is no significant change in the frequent-infrequent user difference in science scores before and after, indicating, that the influence of kiosk usage has no significant impact here. Clearly, the presumption is that the impact of the factor of intelligence on scores in science for frequent users seems stable over the years. There is a significant difference in scores between the user groups both before and after, and the difference has not changed significantly over time. This leads us to think that it is not frequency of usage but intelligence – a stable factor - that has significantly impacted differences in science scores at Shirgao. This should explain why change of differences from March 2002 to October 2004 is not significant.

Table 5. Science ANOVA Differences

	Differences March 2002	Differences October 2004	Change of Difference from March 2002 to October 2004
Frequent – Infrequent	4.66	5.61	0.95
	Significant ($P < 0.05$)	Significant ($P < 0.05$)	Not significant

Differences between Shirgao frequent and infrequent users in school Mathematics results

Table 6 ANOVA results below show that the difference between frequent and infrequent users in Mathematics in March 2002 is not significant, although positive. *In October 2004 however, frequent users have scored significantly higher than infrequent users.*

Additionally, *the change in differences between the two groups over the 2 years is also significant*. In other words, the gap in scores for Mathematics between frequent and infrequent users has widened over the years.

The impact of intelligence on scores of the two groups of users is presumed to have been stable over the years. Two significant findings stand out: first, *higher Mathematics scores of frequent users after the kiosk set up*; second, the *widened gap between frequent and infrequent users in October 2004*. These findings lead us to think that use of the MIE kiosk has impacted Mathematics scores of frequent users at Shirgao.

Table 6. Mathematics ANOVA Differences

	Differences March 2002	Differences October 2004	Change of Difference from March 2002 to October 2004
Frequent – Infrequent	3.39	6.56	3.16
	Not significant	Significant ($P < 0.05$)	Significant ($P < 0.05$)

Discussions of results and conclusions

It appears that frequent users, on account of their higher average intelligence, score somewhat better, than infrequent users on all school examinations during the period of study. This reinforces the premise that scores for Intelligence – and hence its impact – is invariant over time, and hence through the period of exposure to kiosks.

The significant impact of the use of MIE kiosk is seen in the subject of Mathematics for this age level in Shirgao. Frequent users scored significantly higher than infrequent users in Mathematics after the kiosk was setup (October 2004) in comparison to before (March 2002).

The Mathematics software on the kiosk machines includes activities related to learning numbers, shapes, sizes, quantities and patterns; basic operations such as addition, subtraction, division, multiplication; and basic algebra (translate word problems into solvable equations). Any performance in school Mathematics examinations could be impacted by the strengthening of these very basic mathematical skills.

However no significant growth of scores of frequent kiosk users, assignable to the use of kiosks, is seen of post-test scores (October 2004) over pre-test scores (March 2002) in English or Science.

Regarding English and Science results, discussions with the Mathematics teacher, Mr. Shamsuddin Attar, at the Shirgao School, provided interesting insights. School English and Science examinations are based largely on answering textbook questions in a prescribed manner and format from memory. This is often referred to in Indian education as “rote learning”. The software for English and Science learning on the kiosk may not help impact scores based on such rote responses, neither is it adequately relevant to the content knowledge expected by the school curriculum. The school Mathematics examination by nature has to do with problem solving. In Attar’s opinion, these core problem-solving abilities, developed through self-directed learning by groups through the computer kiosk could have impacted school scores in the subject of Mathematics.

Clearly, the impact of the use of MIE kiosks - with the given off-line content - on attainments in English, Science & Mathematics is not uniform. Factors worth examining in future research are the nature of off-line content on the kiosks, the differences in design of learning software and how well the modes of learning fit the modes suited to each subject.

It may be reemphasized that the modes of learning underlying this impact on Mathematics scores remain to be investigated. Impact could be due to the particular Mathematics software in the kiosk computers – its design and content. It could also be that, deeper cognitive processes within the students, are impacted by collaborative work in the computational environment, to improve Mathematics scores. Or, more likely, a combination of both. This needs further study.

Further investigation into the nature of learning at kiosks - including group learning - and relevant Mathematics content could provide a basis for newer design of a self-directed kiosk learning environment. The goal could be a process that further supports and enhances school achievement in this area. The Mathematics learning environment (off-line content) at the kiosk seems already better suited to self-directed learning than the corresponding environments for English & Science.

A similar approach for further investigation could also lead to creation of a better self-directed group learning environment and software design for English & Science.

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Teachers' experiences with computers: A comparative study

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ABSTRACT

Findings from two ethnographic studies regarding teachers' uses of computers from 1991 and 2004 are compared to discover how teachers' experiences of computer have changed since the proliferation of computers in schools and how teachers' experiences of computers have remained the same. Despite the tremendous increase in availability of computers in schools and modest progress in teachers' computer use, a comparison of data demonstrates continuing token integration of computers by teachers. Such factors as lack of effective training, and need for collaboration and involvement in planning for computer use which inhibited teachers' computer use in 1991 continued to exist in 2004.

Keywords

Computer use, Comparative study, Case study, Technology integration

The most visible change that has occurred in public schools in the United States over the past two decades has been the addition of computers in labs and classrooms. According to the National Education Association (2002), one computer was available for every 4.2 public school students nationally in 2001 – as compared to one computer for every 125 students nationally in 1981. Similarly, Internet access was available in 77 percent of instructional rooms by 2000, an increase from roughly 3 percent access in 1994 (Cattagni & Westat, 2001).

One major driving force for this change has been the policy and financial support from the U.S. Government. *A Nation at Risk*, a widely read report produced by National Commission on Excellence in Education in 1983, was the catalyst for developing computer skills among school students, which named computer skills as among the "Five New Basics" (National Commission on Excellence in Education, 1983, p. 24). Eighteen years later, the *No Child Left Behind Act of 2001* repeated this emphasis by including a recommendation that all students should be technologically literate by the eighth grade. Accompanying these policies was a huge amount of funding from the government and private sources. The technology-related investment in K-12 education for infrastructure, professional development and technical support in the ten years from 1993 to 2004 exceeded $40 billion dollars (Dickard, 2003).

However, multiple studies have found unsatisfactory results regarding computer integration in schools (Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, 1999; Peck, 2001; Rogers, 2000). Instead of facilitating teaching and learning in a significant way, computers are found to be "oversold and underused" (Cuban, 2001). Such findings draw our attention from the expectations and potentialities of computer use to the realities of computer use, and prompt us to ask questions such as why are computers underused in schools? Why don't teachers choose to use computers?

Among various explanations and analyses provided by researchers, Fullan's have perhaps been the most systematic (Fullan, 1991). He posits that multiple factors influence the implementation of any changes in education, including the use of educational technology. Teachers are one factor effecting technology implementation in education. In contrast to most studies which treat teachers marginally and simplistically, Fullan suggests that researchers and policymakers examine the changes that are the result of technology integration from teachers' perspectives in order to understand their subjective experiences of the matter in their work context.

The purpose of this research report is to compare the findings from two studies, both of which explored teachers' experiences with computers through prolonged engagement in the teachers' native social settings, their schools and their classrooms (Bichelmeyer, 1991; Shi, 2004, 2005). These two studies were completed 13 years apart (in 1991 and 2004); the comparison of findings from the two studies tells us something about the progress of computer integration in U.S. schools over the past two decades.

Through examination of teachers' concrete experiences with computers and probing of teachers' perceptions regarding these experiences, the researchers shed a unique, interesting and valuable light on the question of computer use in schools. The historical view provided by this comparison, the striking contrast between ubiquitous presence and low use of computers in schools, and the general lack of studies on teachers' experiences with computers in the context of their daily professional activities make this report an important contribution to discourse in the field of instructional technology.

Brief Literature Review

"We're Wired, Webbed, and Windowed, Now What?" is the title of an article by Trilling & Hood (1999) which captures a fundamental question regarding technology integration in schools. Now that billions of dollars have been spent on computers and Internet connectivity, it is appropriate and necessary to ask such questions: How are these computers used? Have teachers and students become experienced users? Have teachers used them to teach in new ways? Have students been able to achieve at higher levels because of the use of computers in teaching?
It may well be argued that the most successful large-scale technology integration project to date has been the Apple Computer of Tomorrow (ACOT), a ten-year long project sponsored by the Apple Computer Corporation. Researchers found that technology impacted teaching and learning and that effective technology integration facilitated student improvement in a variety of skills identified as essential to prepare today's students for tomorrow's world (Sandholtz, Ringstaff, & Dwyer, 1997).

Unfortunately, the success of the ACOT project has been quite the exception in school technology integration. In fact, many research studies report that no significant increase in academic achievement has been found on the part of students as the result of technology integration, though students are reported to show higher interest and motivation in learning (Bryson & Castell, 1998; Schofield, 1997; Schofield & Davidson, 2002).

Reported use of computers by teachers does not offer much promise for impacting teaching and learning, either. According to the National Center for Education Statistics (2000), among teachers who use computers or the Internet at school, 39% of teachers use the computer to create instructional materials, 34% for administrative record keeping, 23% to gather information for planning lessons, and less than 10% of teachers use computers for such activities as multimedia classroom presentations, accessing research about best practices in teaching, communicating with parents and students, or accessing model lesson plans.

Cuban (2001) reports low use of computers by teachers in terms of the frequency of computer use: "[L]ess than 10 percent of teachers who used computers in their classrooms were serious users (defined as using computers in class at least once a week); between 20 and 30 percent were occasional to rare users (once a month); well over half of the teachers were nonusers" (p.133). Employing a critical perspective, Cuban stresses the fact that for those teachers who use computers, they use computers mainly for communication, administrative tasks and creating teaching materials such as student handouts and Internet searches, and "[l]ess than 5 percent of teachers integrated computer technology into their regular curricular and instructional routines " (p.133). From these observations Cuban draws the conclusion that computers in schools are "oversold and underused".

Due to low use of computers by teachers and consistent reports of no significant increase in academic achievement as the result of computer integration, many people have begun to ask how to justify the expenditures made for computers in schools. In an article titled "Our biggest challenge: Proving the power of technologies in educational settings," Peck (2001) observes that a backlash against technologies has begun, admitting that "[t]here are many advocates, but few offer evidence" (p.25). This is echoed by Molenda and Sullivan (2002) when they write that one of the major issues with regard to educational technology in 2001 was that the new media movement with computers (as with previous media such as film, radio, and television) has hit the plateau and that schools are cutting back on high-tech investments as they deal with budget struggles (Molenda & Sullivan, 2002).

In 1985, Bramble and Mason predicted that there would be four phases of integration for educational computing in schools in the United States (Bramble & Mason, 1985, pp. 295-297). The four phases they identified were:

1. Experimentation, 1960-1976, when "methods and terminology are developed…"

2. Popularization, 1977-1985, when "public education enthusiastically adopts computers…"
3. Transition, 1985-2000, when computers "change teaching techniques and redefine the curriculum"
4. Infusion, 2001-?, when computers become "an integral part of the curriculum…"

Obviously, we have experienced the popularization period (at least in terms of the number of computers that are now available in schools). However, the transition period seems to be much more prolonged than Bramble and Mason had predicted, and the future of educational computing is unclear.

This research report will add to the knowledge base by casting light on factors that have influenced technology integration during the transition phase identified by Bramble and Mason. Additionally, this report will provide evidence for and an explanation as to why this transition has been more difficult and longer than these theorists and others who are interested in the integration of technology in schools expected it to be.

Method

This study is a cross-case comparison of findings from two ethnographic case studies regarding teachers' experiences with computers. The two case studies were completed 13 years apart, in 1991 and 2004.

The 1991 study followed the method of naturalistic inquiry (Lincoln & Guba, 1985), while the 2004 study followed the method of critical inquiry (Carspecken, 1996). In both case studies, ethnographic methods were selected as the most appropriate approach for inquiry because they allowed the researchers to become immersed in teachers' worlds through prolonged observation, document analysis, and interview in order to identify teachers' experiences and views regarding important issues around the integration of technology in classrooms. The open research agenda of ethnographic inquiry gave educators opportunity to voice their needs, whereas historically, issues around integration have been defined by administrators and technologists, with little direct input from teachers.

The rich data set that is the result of ethnographic inquiry and prolonged engagement made it possible for the two researchers to compare data about several key factors impacting teachers' experiences with computers, even though neither researcher conducted their original study with the intention of completing this cross-case comparison.

Research Questions

The broad focus for the 1991 study was on educators' subjective experiences with computers and on their perspectives of how to best use computers for communication, professional development, teaching and learning.

The focusing questions for the 2004 case study were: How do teachers use computers in the context of their daily experiences? What do teachers perceive as the important functions of computers in their daily experiences? What impact do computers have on teachers' professional lives?

The focus question for the cross-case comparison was, How have teachers' experiences with computers changed from 1991 to 2004?

Contexts of the Case Studies

Fictitious names have been assigned to all schools, communities, projects, and persons that are named in case study reports throughout this paper.

The 1991 case study. The focus of the 1991 case study was the educational community engaged in the implementation of the IN-CITE computer network. IN-CITE (Information Networks – Computer Integration Throughout Education) was the first computer network to facilitate communication and sharing of resources among educators in its State, which is located in the Plains region of the United States. Four constituent groups were served by the IN-CITE network, including teachers, student teachers, school administrators and librarians. The network linked 17 computers in 16 schools in 6 school districts to a hub station in the Educational Resource Lab (ERL) at the Central University (CU) School of Education.

The hub station at the ERL was a multimedia local-area network equipped to facilitate the development, compilation, organization and dissemination of educational information to all schools linked through IN-CITE.

The IN-CITE stations at each of the 16 participating schools were located in the library or in a teacher work area; each station consisted of a state-of-the-art Macintosh SE with a 20 megabyte hard drive and an Imagewriter II printer. The stations were connected to the hub by a dedicated phone line and modem.

Schools and districts were selected to participate in the IN-CITE project based on representation from across grade levels and cultural settings, minority representation and the number of CU student teachers placed in the district each semester.

The purpose of the IN-CITE project was to facilitate communication among teachers via the network, to familiarize constituents with emerging technology, and to encourage constituents to integrate computers into educational environments.

The 2004 case study. The focus of the 2004 case study was Addison County High School which served about 750 students in Addison County in the Midwestern United States. The largest employer in the county was the district school corporation, which had four elementary schools, one junior high school and one high school. Addison County High School employed about 60 teachers and staff.

The technology department of the school corporation had a staff of five, including the director, a network administrator, one website administrator, one school technician, and one lab supervisor for the high school computer lab.

There were over 200 computers in the high school. Each classroom had a computer station for teachers' administrative use. In addition, the school had four computer labs including an industrial technology lab (about 20 computers), a computer sciences lab (about 15 computers), a business lab (about 10 computers), and a lab for general use (about 30 computers). There were a few additional computer clusters in some of the other classrooms, such as the arts room and the publications room. The computers varied in their configurations, and not all were networked.

Participants

The 1991 case study. Purposive sampling of constituent group members was completed using a serial nomination process in order to achieve maximum variation in sampling. Sixteen teachers, four student teachers, eight librarians, two school administrators and one IN-CITE staff member representing every school that participated in the project were interviewed over a period of nine months. Although the study was primarily concerned with how teachers use computers, interviews with members of the other constituent groups were included in order to gain additional perspectives about issues surrounding the educational and computing environments at each school, about what motivated teachers to use computers, and varying observations and perceptions about how teachers used computers in their daily context.

The 2004 case study. Observation and interviews with nineteen teachers, administrators and technology support personnel at Addison County High School were conducted over a period of eight months. As with the 1991 study, interviews with members of the administrators and support staff were included in order to gain additional perspectives about issues surrounding the educational environment at each school, about what motivated teachers to use technology, and varying observations and perceptions about how teachers used computers in their school environment.

Data Collection Methods

The 1991 case study. This study employed the naturalistic inquiry methodology developed by Lincoln and Guba (1985) which involved four phases of inquiry. First, an orientation was conducted through participant observation and interview in order to discover the salient issues and to determine what additional information was needed. Second, focused exploration was completed using structured protocols in interviews to obtain more in-depth information about the areas identified as most salient to the study. Member checking was completed in the third phase of the study and the case report was revised as a result of the member check. Fourth, an external audit was completed by a researcher with expertise in naturalistic inquiry in order to evaluate the trustworthiness (dependability, confirmability and credibility) of the study.

The 2004 case study. This study employed a critical ethnographic methodology following a five-stage procedure outlined by Carspecken (1996). The first stage involved the compilation of the primary record for the study through the collection of documents and observational data. Stage two involved preliminary analysis to reconstruct the cultural themes and system factors that are often unconscious to the actors by identifying both the routine and unusual events in teachers' daily activities. Stage three involved dialogical data generation through interviews with teachers and other stakeholders of technology integration in the school. The focus of stage four was to develop a conceptual framework in order to discover specific relationships between teachers' use of computers and system factors, and to triangulate this data through member checking and peer debriefing. Finally, the focus of stage five was to apply the identified system relationships as explanations of findings (p. 43).

Instrumentation for both studies. In both studies, tools for recording data included observation logs, interview notes, calendars of daily activities, methodological journals, reflective journals, and document/record files.

Data Analysis Methods

Original case studies. Data analysis was completed separately and independently for each case study. However, both case studies were developed using similar data analysis techniques. For both case studies, data from observation and interview logs, documents and record files were unitized, coded, categorized and sorted. Data units were compared using the constant comparative method (Glaser & Strauss, 1967) and analyzed to discover emergent themes. Both case studies were written using data category structures that evolved through constant comparative analysis into the emergent themes of the study.

Comparison of case studies. The two researchers reviewed the independent analysis categories that developed from each case study, and identified common themes between case studies. Similarities and variations of findings between case studies for each theme were noted. These similar themes, and the similarities and variations of findings within each theme became the structure for the findings and conclusions of the comparison report.

Limitations of the Study

Because the comparison data are from two case studies that were completed by independent researchers with different purposes and in different contexts, this comparison should not be viewed as a longitudinal study, nor should the two data sets be viewed as being related in any way. Because the findings outlined in this research report are not drawn from direct correlations between the two data sets, the findings and conclusions presented should be viewed as interpretive in nature.

Findings

Through the comparative data analysis process, six themes were found to have been identified by participants in both studies as having effects on teachers' experiences with computers in the school environment. These six common themes included 1) accessibility of computers, 2) availability of technical support, 3) perceptions regarding usefulness of computers, 4) appropriate programs for teachers' use, 5) factors facilitating teachers' use of computers, and 6) factors inhibiting teachers' use of computers.

Accessibility of Computers

1991 study. In 1991 the only teachers who had personal computers in their classrooms were the "innovative" teachers; those teachers who were using computers due to their own interest and initiative. None of the teachers' computers were networked to the Internet. The computers that these teachers were using were typically made available through grants, negotiations with school administrators, or through personal purchases. Additionally, the majority of the 16 schools that were the focus of the 1991 study had only one computer lab in the school, usually with about 15-20 computers in the lab. In high schools, these labs were used primarily for computer programming, but in all schools these labs could be scheduled by any teacher who was interested in using them with students for instructional activities. None of the student computer labs were networked to the Internet. The labs were not often used by teachers other than the computer programming teacher for instructional purposes; but when they were, they were generally used by English teachers to allow students to do word processing or by other teachers to administer instructional software programs or for word processing.

2004 study. In the 2004 study, all teachers had personal computers in their classrooms, regardless of how little or much the computer was used to support administrative and instructional activities. Some teachers had several student computers in their classrooms, as well. These student stations were generally found in the classrooms of teachers who were more active computer users, such as the science teacher who created a class website that includes syllabus, schedule and other resources for students. Addison County High School had four computer labs, three for specific courses ranging from 10-20 computers, and one lab for general student use with about 30 computers. Each lab had at least some portion of the computers networked to the Internet. The general computer lab is reported to be busy, with many teachers scheduling classes there when they want to use the LCD projector to present information from the computer to students.

Availability of Technical Support

1991 study. All teachers reported that the technical support provided by school administrator for their computer use was inadequate. In the majority of schools, there was no funded support at the building level, so whatever support was available was generally provided by innovative teachers or the computer programming teacher, who would volunteer time or perhaps receive one course release for their efforts. Funded technical support was generally provided at the school district level. In a few rare cases technical support was provided by outside consultants, or provided through awards from grants or other funding agencies.

2004 study. The majority of teachers reported that the technical support available to them for their computer use was adequate. This perceived adequacy may have been due in part to the fact that there was a number of teachers who were advanced computer users provided support to other teachers (something akin to a larger group of innovative teachers at the building level as described in the 1991 study), as well as to the fact that funded support was available at the school level from the lab supervisor in addition to the district-level support through the technology department of the school corporation.

An interesting difference between the teacher participants in the 2004 study and the 1991 study was that teachers in the 2004 study identified students as one source of technical support. Most teachers in the 1991 study would not have considered the idea of asking for support from students, alternatively, many expressed concern that students would perceive them as technologically incompetent if the computer had a problem that they couldn't fix while working with students. Apparently, teachers in the 2004 study had no such concerns, which would indicate that it has become more acceptable in the past 13 years for teachers to ask for help from students, at least in the area of computer support.

Perceptions Regarding Usefulness of Computers

1991 study. Obviously, personal computers were still very new in 1991, and teachers' perceptions about computers in the 1991 case study reflected the uncertainties that accompany newness. Most of the teachers in that study expressed uncertainty about the value of computers in education while they identified many specific concerns, such as: whether software interfaces could be made more intuitive, whether the speed of Internet connections could be increased, whether software programs from various vendors could be made compatible with each other so that they wouldn't crash so often and so unexpectedly, whether high quality programs could be developed to meet teachers' needs for administration and instruction, and whether enough computer stations could be purchased with tight school budgets so as to make it possible for a majority of students and teachers to use them.

At the same time, a few teachers could imagine the potential benefits of computer use if the uncertainties listed above could be overcome (generally, these were the same teachers who were identified as "innovators"). The perception of potential was based on the possibility of more effective administrative tools for recording data, tracking students and grading; more effective warehousing of instructional resources that could be easily re-used from one semester to the next; and the potential of email and networked applications to break through the barrier of the four walls of the classroom that isolate teachers and students from others in their building as well as the rest of the world.

2004 study. By 2004, the computer had overcome at least a number of the uncertainties that were identified by teachers in 1991. However, while all teachers used the computer in some ways for their daily work, not all of them perceived it as an important tool of education. In fact, only a few teachers were enthusiastic about the changes that computers had brought to their ways of teaching, and most were not that excited. Some felt the ways of teaching were quite the same, and some expressed the view that, while the computer does allow for easy access to information, the quality of that information is often questionable and therefore the computer is still an "immature research tool".

A lingering uneasiness about computer use in education was expressed by a veteran English teacher who represented a very small but vocal minority when he said that the most valuable thing in teaching is the human touch, and that it is important for students to learn to respect others. This teacher said he believes that staring at a computer screen and typing away on the keyboard take away that human aspect of teaching and learning and that it is pitiful that students have no way to develop this respect because "you wouldn't show respect to a screen." However, despite his doubts about computers, he takes students to the lab because he feels they are more motivated when working at computers.

Teachers' Typical Computer Use

1991 study. In 1991, the few teachers who were using computers were using them primarily for administrative purposes such as word processing to create documents for class including assignments and tests and grade book programs or simple databases to record and track grades. As described earlier, if computers were used at all by teachers for instruction, they were used primarily for word processing in English classes. Some of the innovative teachers may have developed a HyperCard stack or some little program to teach a math concept or a scientific principle, but that was the very rare exception. Internet research was very difficult in 1991, when "surfing the net" was still a function of text-based or command line programs because the World Wide Web had not yet been introduced for general use. Neither was the computer used for presentations because LCD panels were not yet available on the general market and computer screens were too small for a teacher to display information to a class of 20-30 students.

2004 study. Given the advances in hardware, software and internet speed, one might expect to see a large difference between teachers in 1991 and 2004 in terms of their typical uses of computers. One with such an expectation would be disappointed. Teachers who participated in the 2004 study were still using computers for primarily administrative purposes (though proportionally many more teachers were using computers for these purposes in 2004 than in 1991). One interesting twist regarding teachers' computer use in this regard, however, is that a mandate from the administration at the school corporation level and the school level resulted in teachers' use of email for internal communication, a student management package for recording grades and taking attendance, and a database to match final examinations with state standards. The primary use of computers for instructional purposes by teachers continues to be for word processing, though the amount of Internet research in class activities is increasing. And there are a few teachers who could be described as engaging in the intensive integration of computers into their classrooms, including creating course websites, posting schedules, assignments and resources on the Web, and having students use computers to complete in-class activities.

Factors Facilitating Teachers' Use of Computers

1991 study. In 1991, the factors that teachers said would facilitate their use of computers were in actuality a wish list, because none of the five factors that were identified were available to teachers at that time. In addition to accessibility, hardware/software stability and technical support, teachers identified the potential for more efficient completion of administrative tasks and potential access to better instructional materials as factors that would facilitate their integration of computers into their daily professional routines.

2004 study. At Addison County High School in 2004, all teachers had personal computers in their classroom, some had student computer clusters in their classrooms, there were four computer labs and more than 200 computers throughout the school – in other words, accessibility was no longer an issue and teachers did not even consider it as a factor that facilitates their use of computers in daily activities.

In the 2004 study, teachers did identify four of the same factors that teachers in the 1991 study named as facilitators of technology integration; however, for teachers in 2004, these factors were not a wish list but rather a dream come true. Teachers reiterated the importance of hardware/software stability and technical support, and they also noted the increased efficiency of administrative tasks and the ability to develop better instructional materials as factors that supported their use of computers. Additionally, in the 2004 study, a majority of teachers cited increases in students' motivation when working with computers as an important reason they use computers.

Factors Inhibiting Teachers' Use of Computers

1991 study. One reason teachers cited in 1991 for why they did not use computers was that they were simply not in the habit of doing so. Another factor related to habit that was identified by teachers as inhibiting their use of computers was intimidation – these machines were unfamiliar, they were not user-friendly, and there was little support available to teachers who were willing to try. Teachers reported that their over-full schedules left them little time to become familiar with computers, which might have helped to decrease their intimidation.

Teachers also noted that the time they did have to dedicate to innovation would be during in-service workshops for professional development activities, but that there was little or no effective training for computer integration offered at these times. A discussion of the elements that lead to effective professional development for teachers' computer use is beyond the scope of this report; suffice it to say that teachers wanted professional development opportunities in which appropriate uses of computers for administration, teaching and learning were demonstrated; that included hands-on activities; that extended beyond a single two-hour session, and that were delivered by individuals who had K-12 teaching experience.

Finally, the participants of the 1991 study noted that teachers spend most of their professional working life isolated from their peers and from administration, and therefore they lack the opportunities to work with others and to be involved in planning for the innovations that they are required to implement in their own classrooms. The lack of collaboration and ownership were identified by teachers as critical factors that inhibited their computer use.

2004 study. Participants in the 2004 study did not name habit, intimidation or lack of time as factors that inhibited their computer use. They did, however, echo the voices of the 1991 teacher participants when they emphasized that the lack of effective training, lack of collegiality and lack of involvement in planning for technology integration were factors that kept them from using computers.

An additional factor cited by teachers in the 2004 study as inhibiting their use of computers was the lack of material support, meaning that, as one might expect in an always financially burdened public school setting, teachers reported having to periodically spend their own money for peripheral devices and supplies (such as computer cables), and that their frustration with this situation was a discouragement from using computers.

In addition, a few teachers identified the standards movement as an inhibitor to their computer use. These teachers felt that the mandate to teach to standards diverts their energy away from truly improving teaching, with or without technology integration.

Summary of Comparative Findings

For two studies that were completed 13 years apart, by different researchers, in different contexts and with different participants, the congruity between themes identified by the teachers who participated in the two studies is striking.

This congruity may be considered as evidence that the same issues that were important to teachers 13 years ago continue to be important to teachers today.

The similarities and variations identified within each theme appear to be the natural result of the now nearly ubiquitous presence of computers in the daily experiences of teachers. Comparative data analysis indicated that computers are more accessible today than they were 13 years ago, both in individual classrooms and labs throughout the school. There is now more formal, funded technical support at the building level for teachers than there was 13 years ago, but there is also more informal support for teachers in the form of their peers, and teachers are now comfortable taking advantage of help from students who are sophisticated computer users, in contrast to teachers 13 years ago who were reticent about looking inept in front of students. Thirteen years ago, most teachers were uncertain as to whether computers would one day be useful tools for education; today more teachers perceive computers as an important tool of the educational process. Most teachers believe that the use of computers increases students' motivation to learn.

That's the good news. There is less positive news, as well. Comparative data analysis also indicated that teachers continue to use computers primarily for administrative tasks and that intensive technology integration for innovative and meaningful teaching and learning is a rarity. It appears that there has been little improvement over the past thirteen years of in-service training or professional development experiences for teachers who want to learn how to fully integrate computers into their daily activities. Teachers still report that they experience a lack of collegiality and lack of involvement in planning for the innovations that they are required to implement in their own classrooms.

Finally, the impact of the standards movement on teachers' use of computers is unknown at this time; however, it appears that it's a mixed bag at best, with some teachers viewing it as a positive influence for computer integration and others viewing it as yet another distraction diverting their energies away from being able to create meaningful teaching and learning experiences.

Conclusions

In 1991 few teachers achieved technology integration in their classrooms due to such fundamental issues as lack of accessibility and technical support. In comparison, the majority of teachers in 2004 appear to have achieved basic levels of computer integration into their daily professional activities. So, the difference between teachers' experiences with computers from 1991 and 2004 is that the majority of teachers have moved from no integration to basic integration of computers into their everyday activities.

However, such basic level of technology integration has been far from changing most teachers' teaching practice and curriculum. At a fundamental philosophical level, the most important elements of teachers' experiences with computers in 2004 appear to be the same as they were in 1991 – and this may well have been expected. In 1986, Cuban (1986) wrote in "Teachers and Machines" that, unlike instructional technologists who are interested in the integration of technology into classrooms for technology's sake, teachers are interested in taking care of their students and will judge the worth of any technology by the ability of that technology to help meet teachers' needs as they attempt to facilitate learning. Like the teachers described by Cuban, the majority of teachers who participated in the 1991 case study reported that they did not consider their non-use of computers as a problem in and of itself. What mattered most to those teachers was that they were engaged in effective teaching to support student learning. Thirteen years later, the majority of teacher participants in the 2004 case study also expressed their ambivalence to the use of computers for their own sake. These teachers, along with their principal, expressed the belief that, while it is important for the administration to provide computers for teachers and students, it is up to teachers to decide whether it is appropriate to use them or not – and that computers are simply tools which do not, in and of themselves, make a teacher good. During one interview, the principal said, "I can take you to a classroom right now with a teacher who uses very little technology [and who is] an incredible teacher. Then I could take you to another classroom to a teacher who uses technology all the time and who is also very good."

So it appears that teachers' ambivalence toward computers and their commitment to meeting the needs of their students reported by Cuban in 1986 and replicated in the 1991 case study continues to be the same in 2004. The wise instructional designer would do well to note this sameness, even as they note the progress that has been made in computer integration. It is very possible that the message represented by this sameness is the key to achieving the highest levels of technology integration as labeled on the hierarchy of teachers' technology needs. If, instead of marketing technology to teachers as an end in itself, instructional technologists were to collaborate with teachers to identify their real problems and authentic needs, then together teachers and instructional technologists may be able to integrate computers into schools and classrooms in ways that will allow teachers to foster learning and achievement for every student.

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Multiple Representation Skills and Creativity Effects on Mathematical Problem Solving using a Multimedia Whiteboard System

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ABSTRACT

The aim of this study is to explore student multiple representation skills and creativity in solving mathematical problems when supported by a multimedia whiteboard system. The subjects were 6th grade primary school students that were tested and selected as excellent students in mathematics. Twenty-one numerical and geometry problems were given to the students in the experiment. The learning activities including problem solving, peer criticizing and response improvement facilitated by the designed multimedia whiteboard system. The findings of this study are that student multiple representation skills are the keys to successful mathematical problem solving. Students with high elaboration ability can take better advantage from peer interactions and teacher guidance to generate more diversified ideas and solutions in mathematical problem solving. In contrast, students with low elaboration ability would have great difficulty in representation skills. We conclude that elaboration ability in creativity is a critical factor that affects student's multiple representation skills. The study suggests that teachers could design mathematical problem solving activities supported by a multimedia whiteboard system to improve student multiple representation skills.

Keywords

Representation, Creativity, Mathematical Problem Solving, Multimedia Whiteboard System

1. Introduction

Recent educational reform in mathematics education emphasizes that students should learn mathematical theory and calculation and also how to develop their reasoning and critical thinking abilities for problem solving. In the new educational reform for the 9-year Consistent Curriculum Syllabus in Taiwan passed in 1999, the main learning objective is for students "to learn how to solve real application problems" in the mathematics domain. Constructivists also claimed that students should discover and build upon their own knowledge. Therefore, the mathematics learning process should be active and meta-cognitive. Teachers should bridge the gaps between learning mathematical knowledge and solving real world problems. Solving a math problem is more than just filling in a blank in a test. Students need to form good expressions in elaborating their solutions. Some researches pointed out that good student representation skills are the key to acquiring a successful solution in problem solving (Gagne, 1985; Mayer, 1992).

While solving a mathematical application problem, students need to observe and find out specific patterns or rules inside the problem. That is, students need to formulate a concrete application problem into an abstract mathematical problem. In the formulation process, students must have multiple representation skills to articulate the same problem in different forms or views. However, some researchers pointed out that most students fail to grasp the importance of the connections between different types of representations (Ainsworth, 1999). Lesh (1987) proposed a three steps procedure for problem solving. The first step is translation of verbal or vocal to mathematical pattern, the second step is transforming the mathematical pattern into arithmetic symbol. The final step is explaining the solution by verbal writing or oral speaking. Lesh emphasized the importance of student transformation ability among multiple representations in solving application problems.

Students in mathematics class usually acquire knowledge by listening to their teachers and then taking some quizzes. There is not enough time for all students to elaborate their problem solutions using multiple representations in class. It is also not easy for some students to speak out their detailed explanations due to face-to-face pressure in class. As for quizzes, many mathematics teachers prefer a simpler test form like multiple choice and filling in blank questions rather than giving complex problem solving. Therefore, most students are trained to acquire knowledge through the first and second steps in problem solving proposed by Lesh (1987). They seldom have the chance to explain their solutions using verbal or written problem solving. However, without the final step, teachers cannot truly determine if a particular student misunderstands the problems solving process.

Cultivating better creative thinking ability in students has become an important trend in educational revolution. The mathematical problem solving process involves divergent thinking with many tools and requires more effort and time. However, it is not easy to cultivate student creative thinking ability in traditional classroom. This is because most students simply apply the formulas they have learnt to solve problems, but do not necessarily understand the real concepts or principles behind the formulas (Baer, 1993; Forbes, 1996).

To better understand student learning obstacles and cultivate creative thinking ability, teachers need to assess student solution procedures in detail, especially the multiple representations for their solutions, including formulas, graphs and language such that teachers can determine if students misunderstand a certain concept or are stuck at a specific point. Teachers can then provide more effective guidance to students. Sung also pointed out that the peer evaluation processes should be employed to help students understand the problem properties and reflect on their own solutions (Sung, et al., 2005). This can then strengthen student creative thinking ability and creativity.

According to the premises stated above, this study explores how primary school students use multiple representations including text, graphs, symbols, rules, and formulas in mathematical problem solving; and how a multimedia whiteboard system can be used to support students in doing multiple representations. This study also wants to examine the relationship between student creativity ability and multiple representation skills and the impact on mathematical problem solving. The main research questions are described as follows:

1. How does student multiple representation skills affect mathematical problem solving using a multimedia whiteboard system?
2. How does student elaboration ability in creativity affects their multiple representation skills in mathematical problem solving?
3. What are the advantages and disadvantages of using a multimedia whiteboard in mathematical problem solving?

2. Literature Review

2.1 Representation

The meaning of representation can be different in different contexts. There are external representations (real world) and internal representations (mind). In psychology, representation means the process of modeling concrete things in the real world into abstract concepts or symbols. Jonassen (2000) also interpreted mental models as complex mental representations composed of numerous kinds of mental components including metaphorical, visual-spatial, and structural knowledge.

In mathematical psychology, it means the description of the relationship between objects and symbols. Lesh, Post & Behr (1987 pointed out five outer representations used in mathematics education including real world object representation, concrete representation, arithmetic symbol representation, spoken-language representation and picture or graphic representation. Among them, the last three are more abstract and a higher level of representations for mathematical problem solving (Johnson, 1998; Kaput, 1987; Lesh, 1987; Shiau, 1993; Zhang, 1997; Milrad, 2002):

1) Language representation skill – The skill of translating observed properties and relationships in mathematical problems into verbal or vocal representations.

2) Picture or graphic representation skill – The skill of translating mathematical problems into picture or graphic representations.
3) Arithmetic symbol representation skill – The skill of translating mathematical problems into arithmetic formula representations.

Some students favor visual or concrete representations, while others favor symbolic or abstract representations. Normally, students with good problem solving abilities are those that can skillfully manipulate their language translation and representations (vocal), picture representation (picture, graphic) and formal representation (sentence, phrase, rule and formula). On the other hand, students with low problem solving abilities are always having difficulty with translation and representation in problem solving. Furthermore, different students have different learning styles for acquiring knowledge. It is better for teachers to adopt different teaching strategies to promote students performing multiple representations in class, thereby enhancing learning performance (Cai & Hwang, 2002).

To support students in performing multiple representations for problem solving, ICT tools can be used to better facilitate the learning process. Hwang (Hwang et. al., 2006) proposed using a multimedia whiteboard system for students to express their thoughts (internal model) with text, image or oral. Most students were satisfied with the usefulness and ease of using the multimedia whiteboard system (average score higher than 4.2 in Likert 5 point scale) in this study.

Multi-modal learning simply means using many ways to learn. Multi-modal learning promotes the use of new media and methods designed and offered by communication and computer technology. (Jeffery, 1993; Pilgrim, 1996) When solving mathematical problems, students first figure out some clues to solve the problem by trying different approaches like using formula, graphic reasoning or textual explanation. They then translate their ideas and methods into multi-representation solutions using various tools supported by the multimedia whiteboard system as shown in Figure 1.

Problem solving is the highest level of knowledge in the Bloom cognitive taxonomy (1956). Anderson et al (2001) revised Bloom cognitive taxonomy into a new learning process which including 'remembering', 'understanding', 'applying', 'analyzing', 'evaluating' and 'creating'; among them creativity is listed at the highest level. Therefore, we argue that creativity would have a profound effect on multiple representation skills in the learning process. We will discuss more about this issue in the following section.

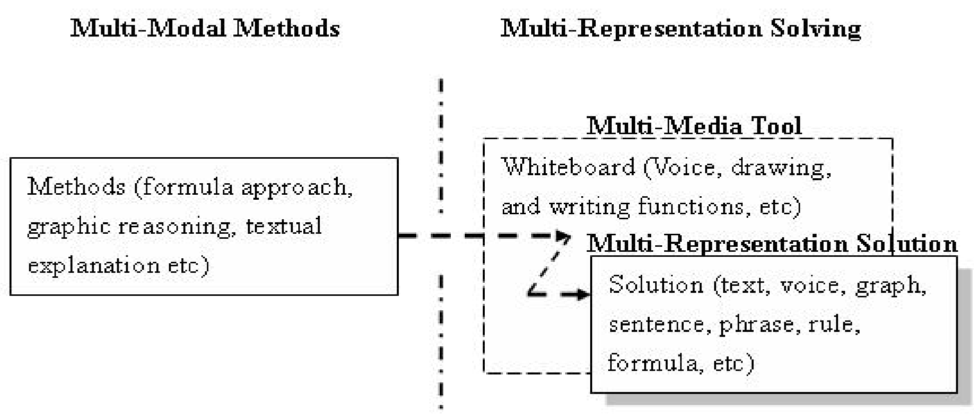


Figure 1. Translation from multi-modal methods into multiple representation solutions

2.2 Creativity

Creativity means the cognitive skill of proposing a solution to a problem or making something useful or novel from ordinary. Guilford cited the paucity of creativity and imagination among all students, and encouraged the study of creativity. Creativity requires six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment (Gerard, 1999; Lubart & Sternberg, 1996; Mayer, 1992; Tennyson, 2002).

Williams (1971) also proposed the definition of creativity based on Guilford's multiple intelligence theory (1969) and emphasized the importance of creativity on learning. According to Williams's definition of creativity, it is composed of six cognitive factors, fluency, openness, flexibility, originality, elaboration and title as well as four affective factors, curiosity, imagination, challenge, and risk-taking. Sternberg (1999) also articulated that cognitive abilities and affective factors will influence the extent of creative problem solving.

The most prevalent creative problem solving process was developed by Isaksen, Dorval, and Treffinger (2000). It consists of four components:

1) Understanding the problem
2) Generating ideas
3) Preparing for action
4) Planning the approach

The first component has three stages (a) Constructing the opportunities, in which the problem is presented in a mess; (b) Exploring the data, in which the background of the problem is investigated; (c) Framing the problems, in which the problems is explicitly identified. The second component has only one stage; (d) Generating ideas, in which many relative ideas are gathered and generated. The third component, preparing for action, has two stages; (e) Developing the solution, in which the solutions are narrowed and fleshed out; (f) Building acceptance, in which the solution step details are identified. The final component, planning the approach, has two stages; (g) Appraising tasks, which assesses the appropriateness of the method, and (h) Designing process, in which the solution method details are accomplished (Canady, 1982; Firestien & Treffinger, 1983; Howe, 1996; Jennifer, 2003; Osborn, 1953; Parker, 1978).

Wallas (1926) proposed that creativity involves four stages: preparation, incubation, illumination, and verification. During the preparation stage, one must be conscious of the problem and gather related information or draw upon previous experience. During the incubation stage, the person will consider all possible solutions, but he or she may fail. During the illumination stage, one innovative idea may suddenly come to the person, often in an unconscious situation. During the verification stage, the solution will be executed and verified.

Osborn (1953) also provided four guidelines for creative problem solving for teachers to apply in the classroom environment to encourage more ideas, to accept strange ideas and to promote ideas, but not criticize ideas immediately after the students presented them (Johanna, 2003). Creativity seems a natural talent of people. However, creativity is a cognitive skill for proposing a solution to a problem, or making something useful and novel from the ordinary (Anderson et al, 2001). That means creativity is a skill that can be cultivated through the problem solving process. As the literature described above, several systematic procedures could promote creativity in solving problem. However, the assessment of student performance cannot be just either right or wrong for the solutions. More creative evaluations should be used, for example, using open-ended assessments can help students to reveal their thinking, reasoning and strategic used in the solving process.

2.3 QCAI Evaluation

Silver (1989) conducted a project called QUASAR (Quantitative Understanding Amplifying Student Achievement and Reasoning). Its attempt is to promote different learning methods to cultivate student problem solving and creative thinking abilities that can help all levels of students to learn math well. Under this premise, teachers need to adopt multiple materials and instructional strategies to encourage students to do discussion, interpretation and innovation. In this way, students will be trained to thinking about math instead of memorizing math.

Several evaluation instruments were developed in QUASAR projects (Ford Foundation, 2004; Lane, et al, 1995; Lane, 1999; Lane & Wang, 1996; NCTM, 1989; Moskal & Leydens, 2000; Parke, 2002)... The most famous and prevalent one is QUASAR Cognitive Assessment Instrument, which is also called QCAI with many open-ended questions. QCAI can evaluate student mathematical problem solving, reasoning, communication and representation skills, etc. The QCAI specification includes 4 components: mathematical contents, cognitive processes, representation mode (text, picture, graph, table) and task context (embedded in real world or not).

The general QCAI scoring rubric is specified for each of 5 score levels. Five score levels are used to capture various levels of student understanding. The sixth and seventh grade version of the QCAI consists of 36 open-ended tasks that are distributed into four forms, each containing 9 tasks (Lane, Stone, Ankenmann, & Liu, 1994). Based on the specified criteria at each score level of the general rubric, a specific rubric was developed for each task. The emphasis on each component for a specific rubric is dependent on the cognitive demands of the task. The criteria specified at each score level for each specific rubric are guided by theoretical views of the acquisition of mathematical knowledge and processes assessed by the task, and the examination of actual student responses to the task. The examination of the student responses ensures that the rubrics reflect the various representations, strategies, and ways of thinking (Lane, et al, 1996). This study focus on the types of multiple representation skills (text, voice, picture, graph, symbol and rule) in QCAI and use the 5 levels scoring rubric to evaluate multiple representation skills as shown in part A of Table 1.

3. Research Method

3.1 Setting & Procedure

The subjects were 25 six-grade primary school students in different classes who were tested and selected as excellent students in mathematics in the school. They participated in the mathematical problem solving learning activity using multimedia whiteboard system (Hwang etc., 2006) on the K12 Digital School, http://ds.k12.edu.tw/.

The designed multimedia whiteboard system has drawing tools, voice recording tools and editing functions. Students write down and modify their solutions and explanations on their own whiteboards, which then stores this information in the form of a discussion forum on a web site. The multimedia whiteboard system has the following functions: the drawing tools include the line, circle, rectangle and text. The editing functions including copy, paste, cut, move, undo and redo and the voice recording function, as shown in Figure 2.

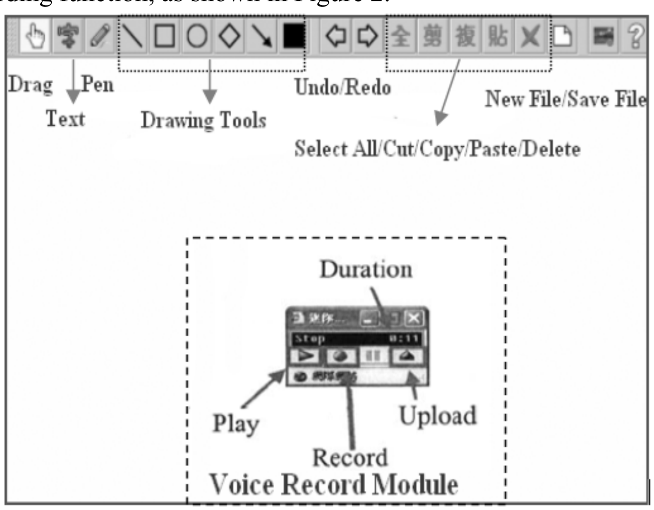


Figure 2. The user interface of voice recording in the designed multimedia whiteboard system

Students were given 21 problems by the teacher including 16 numeral problems and 5 geometry problems. Numeric problems contain the concepts about arithmetic series, geometric shapes, factors, multiple items and number applications, etc. Geometric problems contain the concepts of volume, area of surface, etc. Most students have computers and Internet connections at home, allowing them to work on the problem in class or after school.

The period for conducting the experiment was one semester (about 4 months). The students participated in two math class sessions for a total of 80 minutes every week. In the experiment, students were first given two week tutorials to learn how to use the multimedia whiteboard system. After that, one week is given for solving problems followed by another week for mutual criticizing and response activities until the end of the semester. The math teacher supervised and guided the students in the class learning activities using the multimedia whiteboard system. This included solving problems, criticizing other students' solutions and responding to comments made by other peers. Figure 3 shows examples of three kinds of activities, problem solving, criticizing and responding made by the student and teacher respectively.

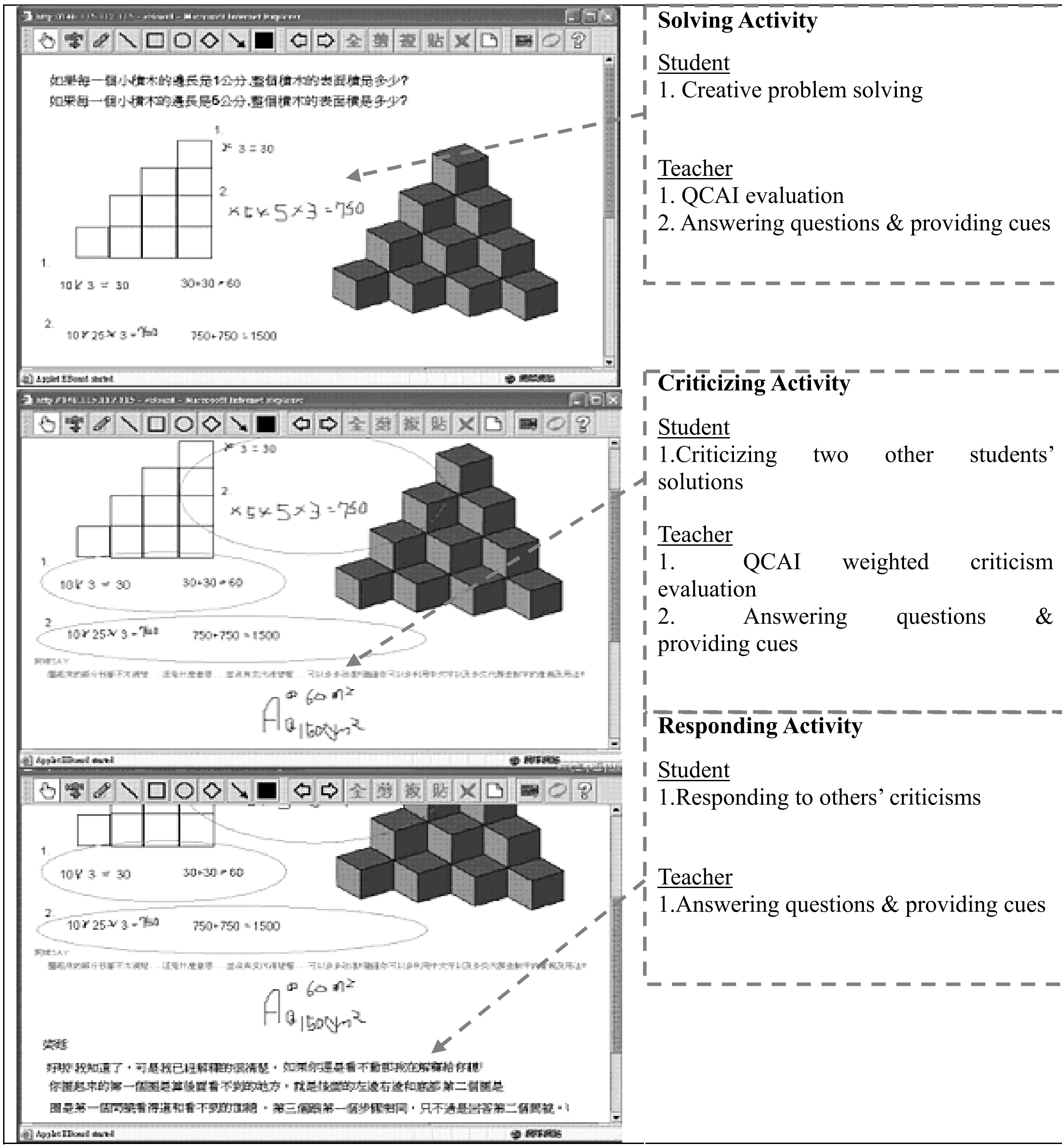


Figure 3. Three examples using multimedia whiteboard for mathematical problem solving

3.2 Evaluation Criteria

During the problem solving process, students were able to revise their solutions many times. The research involved how many kinds of solutions (quantity grade) students could create but also the quality of their solutions (quality grade). The student solutions were classified and evaluated into three types of representations: Text or Voice

Representation, presented as 'T'; Graph or Symbol Representation, presented as 'G'; Rule or Formula Representation, presented as 'R'. Each representation was marked with a quantity grade and a quality grade respectively.

For quantity grade, the assessments were based on how many solutions provided. Two math teachers reviewed student solutions and devised a consensus grade for every individual student after discussion. The assessments were based on how good the solutions were. The teachers evaluated student solutions according to Solution Quality Evaluation Criteria, which revised by the researchers based on QCAI evaluation concept. The score was ranked into 5 categories (Level 1 ~ Level 5), shown in part A of Table 1.

The students were asked to solve problems and also criticize two other students' solutions. Referring to revised Bloom's Taxonomy (1956), criticism requires a higher level of cognitive ability. In this research, the teachers evaluated each student's criticism content according to the Criticism Evaluation Criteria shown in part B of Table 1. The criticism performance was not evaluated in isolation but corresponding to the evaluated solution performance. For example, if a solution was quite good, it was not easy to give critical criticism on that. Therefore each student's criticism grade needed to be weighted on the basis of the solution grades of the student being criticized. The weighted criticism grade could then be obtained by adding the solution grade of the student being criticized according to part A of Table 1. The original criticism grade was obtained according to part B of Table 1 (Weighted Criticism Grade = Criticism Grade + Solution Grades of the Student being Criticized).

Table 1. QCAI Evaluation Criteria

Part A: Solution Quality Evaluation Criteria
Level 5：Correct, the arithmetic calculation and verbal or graphic explanation are both correct and complete.
Level 4：Correct, the arithmetic calculation and verbal or graphic explanation are both correct but incomplete.
Level 3：Correct, the arithmetic calculation is correct but no verbal or graphic explanation.
Level 2：Not correct, the mathematical reasoning sounds ok but answer is incorrect. Or, the answer is correct but no arithmetic calculation process.
Level 1：Trying to solve problems.
Part B: Criticism Evaluation Criteria
Level 5 : Criticism is mathematical relevant and correct. The arithmetic calculation and verbal or graphic explanation are both correct and complete.
Level 4 : Criticism is mathematical relevant and correct. The arithmetic calculation and verbal or graphic explanation are both correct but incomplete.
Level 3 : Criticism is mathematical relevant and correct. The arithmetic calculation is correct but no verbal or graphic explanation.
Level 2 : Criticism is mathematical relevant but incorrect. The mathematical reasoning sounds ok but answer is incorrect. Or, the answer is correct but no arithmetic calculation process.
Level 1：Criticism is mathematical irrelevant or no criticism.

The teachers also conducted the Williams creative test – a Test of Divergent Thinking in the middle of the semester to collect various aspects of student creativity. At the end of the experimental period all students took a final exam with 10 problems. The final exam scores were for evaluating the learning effect. The Williams's Creativity Assessment Packet (CAP), for ages from 9 to 17, contains two types of tests; a test of divergent thinking and test of divergent feeling. This research adopted only the test of divergent thinking which Lin and Wang (1994) had modified to a Chinese version. Six major abilities were measured in this test including fluency, openness, flexibility, originality, elaboration and title. The test's half-reliability is .41 ~ .92; Cronbach alpha is .40 ~ .87; test-retest reliability is .49 ~ .81 (Guidance In Jiouhu, 2005; Psychology Press, 2005).

3.3 Research framework

To explore the effects of multiple representation skills and creativity on mathematical problem solving, the students were classified into different groups according to their solution representation styles. T test and One-way ANOVA were used to analyze the differences in solution, criticism and academic achievement. Pearson Correlation analysis was conducted for representation skills and creativity. The research framework is shown in Figure 4.

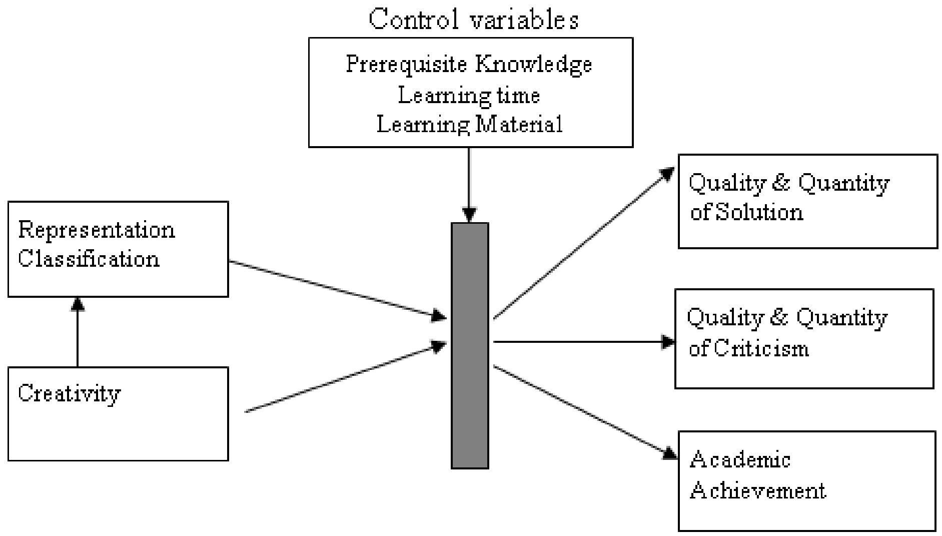


Figure 4. The Research Framework

4. Result & Discussion

4.1 Solution Type Analysis

Two teachers evaluated the student solutions according to the QCAI Evaluation Criteria presented in Table 1. In the Pearson Product-Moment correlation test, 14 out of 16 problem grades were correlated significant between two teacher evaluations. The coefficient is .01 at the alpha level, which validates evaluation reliability.

In the analysis of the students' representation performance, R (Rule or Formula) was better than T (Text or Voice) and G (Graph or Symbol) on both the quantity and quality scores. The T grade distribution was more centralized than the other two representations. The detailed data is shown in Table 2. This result matches with one teacher's observation from the student problem solving process. She made the following comment:
"During the solving activity, most students did not have ideas about how to creatively solve the problem, but simply applied their remembered formula to get an answer."

Table 2. Grades Comparison among Three Different Representation Skills

	Text or Voice Representation (T)		Graph or Symbol Representation (G)		Rule or Formula Representation (R)	
	M	SD	M	SD	M	SD
Numeral-Quantity (9)	7.82	1.22	6.64	2.08	8.52	0.88
Numeral-Quality (45)	26.12	6.36	22.84	9.16	31.82	4.39
Geometry–Quantity (5)	3.12	1.67	3.18	1.53	4.86	0.45
Geometry–Quality (25)	11.92	7.29	12.32	6.53	22.08	3.43

One student also said that it was not easy for him to use verbal, text, or graph to explain the meaning of his solutions.
"Giving answers to the Arithmetic series problems was easy for me. But I had great difficulty in giving further oral explanations and writing down texture description about my solutions."

However, once students can successfully explain their solutions, they would become more comprehensive about the problem.

4.2 Representation Skill Analysis

Student representation performance, both in quality and quantity were recorded and analyzed respectively. One-way ANOVA analysis and Scheffe's test were used to compare the representative scores for T, G, and R in numerical, geometry and the total. The result was divided into four representation types according to the students' representation performance:

1) Representation T was significantly lower than G and R, denoted as type $\boxed{GR}$.
2) Representation G was significantly lower than T and R, denoted as type $\boxed{TR}$.
3) Both representations T and G were significantly lower than R, denoted as type $\boxed{R}$.
4) No significant difference among three representations, denoted as blank (NULL).

The result shows that most students got type $\boxed{R}$ or type NULL; while only a few students got type $\boxed{TR}$ or type $\boxed{GR}$ in Numeral, Geometry or Total. All students' types are shown in Table 3.

Table 3. Student's Representation Types

Student	Numeral Quantity/Quality	Geometry Quantity/Quality	Total Quantity/Quality	Student	Numeral Quantity/Quality	Geometry Quantity/Quality	Total Quantity/Quality
01	$\boxed{TR}$ / $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$	14	/	$\boxed{R}$ /	$\boxed{R}$ / $\boxed{R}$
02	$\boxed{R}$ /	$\boxed{R}$ / $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$	15	/ $\boxed{R}$	/ $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$
03	/	/ $\boxed{R}$	/ $\boxed{R}$	16	/ $\boxed{R}$	/	$\boxed{R}$ / $\boxed{R}$
04	/	/	/	17	$\boxed{TR}$ / $\boxed{TR}$	$\boxed{R}$ / $\boxed{R}$	$\boxed{TR}$ / $\boxed{R}$
05	/	/	/	18	/	/	/
06	/	/	/	19	/	/	/
07	/	/ $\boxed{R}$	/	20	/	/	/ $\boxed{R}$
08	$\boxed{TR}$ / $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$	$\boxed{TR}$ / $\boxed{R}$	21	/	/	/
09	$\boxed{TR}$ / $\boxed{TR}$	/ $\boxed{R}$	$\boxed{TR}$ / $\boxed{TR}$	22	/	/	/
10	/	$\boxed{GR}$ / $\boxed{GR}$	$\boxed{R}$ / $\boxed{GR}$	23	/	/ $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$
11	/	$\boxed{R}$ / $\boxed{R}$	/ $\boxed{R}$	24	/ $\boxed{TR}$	$\boxed{R}$ / $\boxed{R}$	$\boxed{TR}$ / $\boxed{TR}$
12	/	/	/	25	/	/	/
13	/	/ $\boxed{R}$	$\boxed{R}$ / $\boxed{R}$				

Students of the types $\boxed{R}$, $\boxed{GR}$, or $\boxed{TR}$ seemed to favor using one or two representations in problem solving or criticism. Those students were classified as "Unbalanced Style" in our study. Those students that used all representations fairly were classified as "Balanced Style". The representation styles and the corresponding symbols are shown in Figure 5.

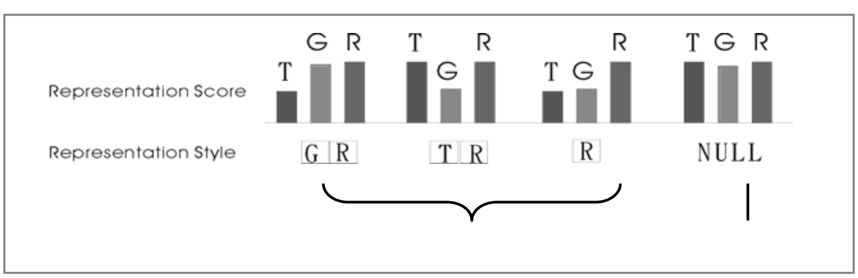


Figure 5. Representation Styles and Symbols

4.3 Performance Analysis of Different Representation Styles

Based on the revised Bloom's taxonomy, the higher level learning processes such as 'analyzing', 'evaluating' and 'creating' need various perspectives for problem solving. Moreover, according to the creativity theory, generating new ideas and thinking are very crucial to finding a good solution. The researchers, therefore, assume the Balanced Style students have higher creativity power than Unbalanced Style students. The Balanced Style students performed better than the Unbalanced Style students in problem solving.

To properly investigate students' favorite representation styles, both quality and quantity performances were taken into account. The researchers classified 13 students (ID 01, 02, 08, 09, 10, 11, 13, 14, 15, 16, 17, 23, 24) as Representation Unbalanced Group and the other 12 students (ID 03, 04, 05, 06, 07, 12, 18, 19, 20, 21, 22, 25) as Representation Balanced Group. Independent sample T test is used on creativity, problem solving, weighted criticism, and academic achievement. The results are shown in Table 4.

Table 4. T test of Representation Styles between Balanced and Unbalanced Groups

		Balanced Group (N=12)		Unbalanced Group (N=13)		t value	
		M	SD	M	SD		
Creativity	Fluency	23.50	1.24	24.00	0.00	-1.39	
	Flexibility	13.92	2.42	14.46	2.22	-.57	
	Originality	28.25	6.78	30.92	7.67	-.92	
	Openness	57.25	5.70	54.38	9.78	.88	
	Title	39.83	8.26	37.38	7.05	.80	
	Elaboration	27.25	7.94	19.46	8.31	2.39	*
Problem Solving	Total-Quantity	74.75	5.99	62.69	9.02	3.90	**
	Total-Quality	286.25	46.21	225.00	43.31	3.42	*
	Numeral-Quantity	24.13	2.21	21.89	3.72	1.81	
	Representation T	7.63	1.23	8.00	1.24	-.76	
	Representation G	8.03	.73	5.31	2.05	4.58	***
	Representation R	8.42	.82	8.62	.96	-.55	
	Numeral-Quality	88.54	15.37	73.89	16.80	2.27	*
	Representation T	27.46	6.57	24.89	6.15	1.01	
	Representation G	28.54	5.31	17.58	8.91	3.77	***
	Representation R	32.25	4.34	31.42	4.57	.46	
	Geometry-Quantity	13.25	1.90	9.46	2.16	4.63	***
	Representation T	4.33	1.07	2.00	1.29	4.89	***
	Representation G	4.13	1.09	2.31	1.38	3.64	***
	Representation R	4.71	.62	5.00	.00	-1.63	
	Geometry-Quality	54.58	12.34	38.62	10.09	3.55	**
	Representation T	17.13	5.79	7.12	4.86	4.69	***
	Representation G	16.00	5.50	8.92	5.61	3.18	**
	Representation R	21.54	3.99	22.58	2.90	-.75	
Weighted Criticism		125.86	11.30	114.70	8.76	2.39	*
Academic Achievement	Pre-test	95.31	3.35	95.58	2.39	-0.22	
	Post-test	95.63	3.08	94.39	3.36	0.97	

(* $p < .05$, ** $p < .01$, *** $p < .001$)

The Balanced Group students performed better than the Unbalanced Group in the Elaboration item of Williams's creativity package (t=2.39*). No significant difference was exhibited in the other five items, Fluency, Flexibility, Originality, Openness, and Title. For the problem solving solutions analysis, the Balanced Group students performed significantly better than the Unbalanced Group students in Total–Quantity (t=3.9**) and Total-Quality (t=3.42*) scores.

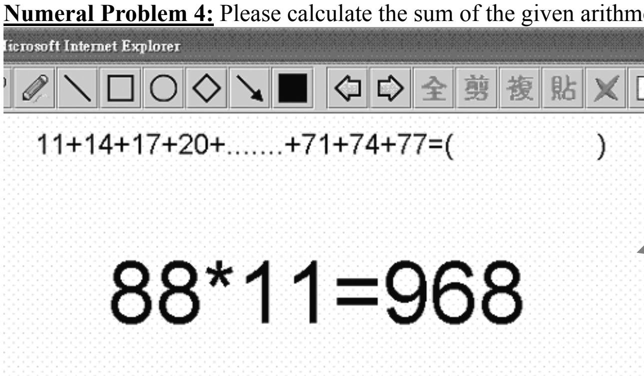
The representation T and G were the critical factors that caused different performance. For the Numeral problem section, the Balanced Group had higher representation G scores than those of the Unbalanced Group both in quantity (t = 4.58***) and quality (t=3.77***). Moreover, for the Geometry problem section, the Balanced Group also had higher representation G scores than the Unbalanced Group both in quantity (t=3.64***) and quality (t =3.18**). Furthermore, the T representation scores showed the same situation between the two groups in both quantity (t=4.89***) and quality (t= 4.69***).

As for weighted criticism scores, the performance of the Balanced Group was better than the Unbalanced Group (t=2.39*). In summary, the T and G representation skills were the key for students in acquiring higher performance, regardless in Numeral or Geometry problem solving and peer assessment.

As for representation R, there was no difference between the two groups. This situation could be explained by the teacher's observation, of which most students in the Unbalanced Group often applied their pre-remembered formulas to solve problems without thoroughly comprehending the problems. Those students were used to memorizing mathematical formulas and employing the formulas directly to solve given mathematical problems. In this case, students could not brainstorm and think deeply and broadly. Thus they had little chance to find good solutions in creative problem solving.

As for no significant difference in the academic achievement between the two groups, the possible reason could be the 25 students participated in our research were all math-talented students in the school. They always got very high marks. This can be supported by the average score close to 95. This phenomenon is called the ceiling effect.

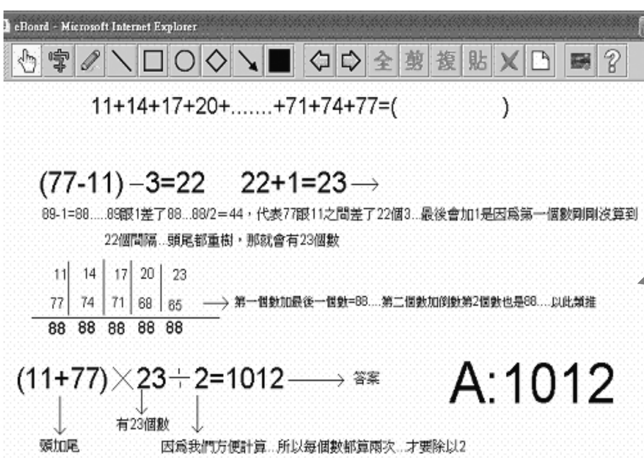
<u>Numeral Problem 4:</u> Please calculate the sum of the given arithmetic series problem.



<u>Teacher's comments on the two solutions for the same Student ID24</u>

First trial

The student solved the problem for the first time and the answer was wrong.
He applied only straight forward thinking to solve this problem without any description and explanation.



Second trial

After the student participated in peer interaction using the multimedia whiteboard system, he learned how to solve this problem. He then solved the problem again after one month, with the correct answer and a proper description and explanation for his solution.
Note: There is a typo error in the equation (77-11) - 3 = 22, the – 3 should be ÷3.

Figure 6. Students with high elaboration ability can perform multiple representations well through interactions

4.4 Effect of Elaboration Ability on Representation Skills

Because the two group students had significantly different performances on T and G representation and the creativity test elaboration item (M=10.16, SD=4.24), the relationship between representation skills and creativity should be further investigated. Pearson correlation analysis was conducted. The results showed that elaboration in creativity was significantly correlated with representation T, and G in several given problems. In Numeral problem section, the quality scores of both T (r = .479*) and G (r = .406*) are correlated to elaboration. Besides, in the total scores, representation T is also significantly correlated with elaboration in quantity (r = .437*) and quality (r = .472*), (* stands for $p < .05$).

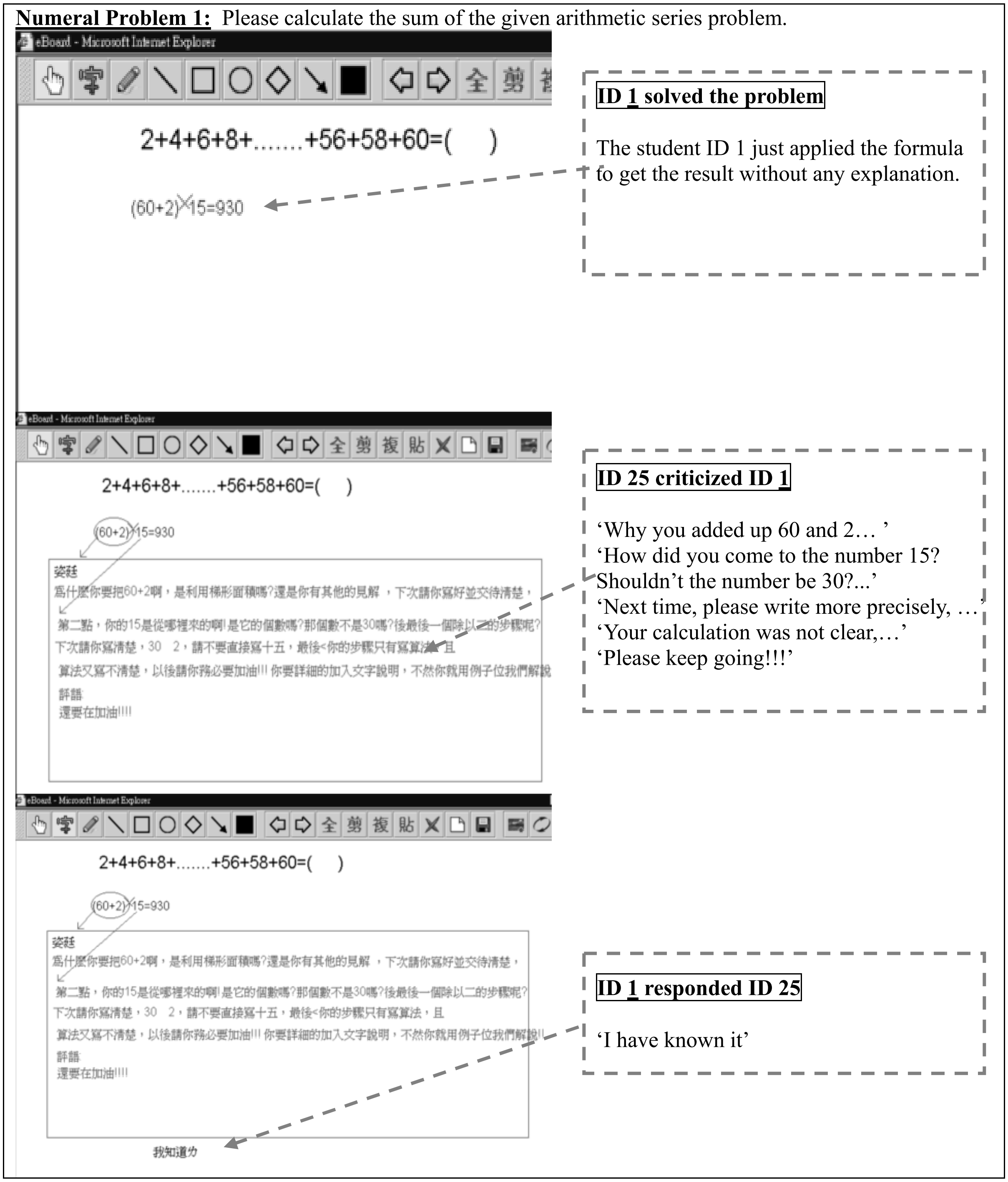
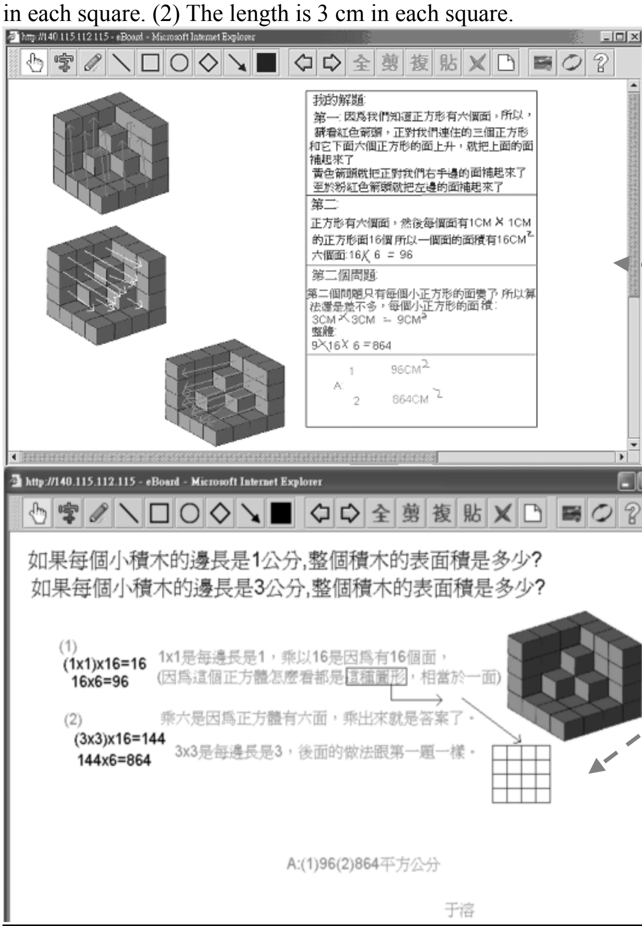


Figure 7. Students with low elaboration ability cannot manipulate multiple representations well

The meaning of elaboration is the ability to work a problem out using extra material, illustration or detail clarification. Therefore, the role of elaboration in solving and criticizing activities is the ability of students to elaborate their own solutions or to criticize others' solutions using various methods and perspectives. Elaboration is the critical factor affecting student's ability to use T and G representation in creative problem solving. It is really worthwhile to stimulate or cultivate a student's elaboration ability using different representations to improve mathematical problem solving.

Let us examine two examples to see how elaboration affects multiple representation skills. In Figure 6, the student ID 24 gave two solutions to a numeral problem using the multimedia whiteboard system. The student got a very high elaboration score, 15 points, which is much higher than the mean elaboration score. The student gave a wrong solution for the first trial (Upper half part of Figure 6), only an arithmetic equation (representation R) was given without any explanation. However, after several weeks of interaction with peers and the teacher, a correct answer and detailed textual explanations (representation T) were given in the second trial (Lower half part of Figure 6). Therefore, elaboration can promote student T and G problem solving representation skills, which can be improved and acquired by peer interaction with the teacher's help. In contrast, the student ID 1 with low elaboration could not perform well in representation when explaining his solution, as shown in Figure 7. The student got only 8 elaboration score points, which is lower than the average. He gave only one solution to a similar numeral problem using the multimedia whiteboard (Upper part of Figure 7). Although other students gave good suggestions and asked him to give detailed explanations (Middle part of Figure 7), 'I have known it' was only written in his response (Lower part of Figure 7). These two examples showed that elaboration is one of the critical factors affecting a student's T and G problem solving representation skills.

Geometric Problem 5: Please calculate the total surface area of the shape in two sub-questions. (1) The length is 1cm in each square. (2) The length is 3 cm in each square.



ID 25's Solution

The student realized that even though the front surface is not flat, if he lifted up every cube toward the boundary the surface will be a complete flat one. The surface area for the three visible dimensions were 3 4x4 squares and the invisible surface area for the other three dimensions were also 3 4x4 squares. Therefore, the total surface area is 4x4x6=96 cm^2 for the first sub-question.
He then got the surface area of 864 cm^2 using the same method for the second sub-question.

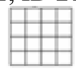
ID 21's Solution

To see is to believe. The student got a figure of 16 squares sharp from 6 different sides. She then calculated the surface as 16 X 6 = 96 cm^2 for the first sub-question. She then got surface area of 864 cm^2 using the same method for the second sub-question.

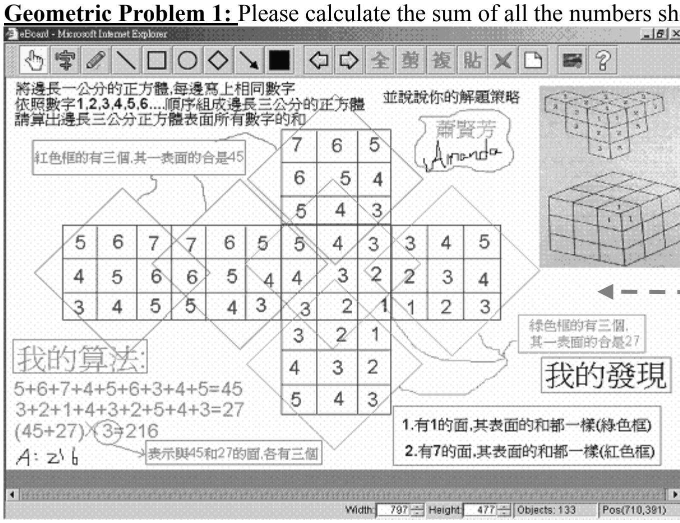
Figure 8. Various aspects and explanations for the same equation

4.5 Problem Solving Analysis

Mathematical problem solving using the web-based multimedia whiteboard system was a new experience for the students that participated in this study. In comparison with face-to-face environments, the web-based system has several advantages like whole solutions and criticizing content can be recorded automatically by the system and reviewed by the teachers and students anytime and anywhere. The students can communicate with each other such that more creative solutions can be stimulated through interaction, discussion and criticism learning activities. Students can modify and improve their solutions many times after receiving feedback from teachers or other students.

For example, Figure 8 shows an example of various aspects and explanations for the same equation. In the first sub-question for geometric problem 5, both students ID 25 and ID 21 got the correct solution: 16 X 6 =96, but gave different strategies and explanations. ID 25 found there were 3 flat surfaces and 3 irregular surfaces in the irregular shape. He figured that each cube in the irregular surfaces could be pulled out to make an irregular surface into a virtual flat one. The irregular shape then becomes a big square with the same surface area as the irregular surface. Therefore, the total surface area 6 X 16 can be easily obtained. However, ID 21 investigated each surface area from 6 different directions in 3 dimensions, and she got the same surface area  in each direction. She then calculated the total surface area as 6 X 16.

Geometric Problem 1: Please calculate the sum of all the numbers shown on the 3x3 cube.

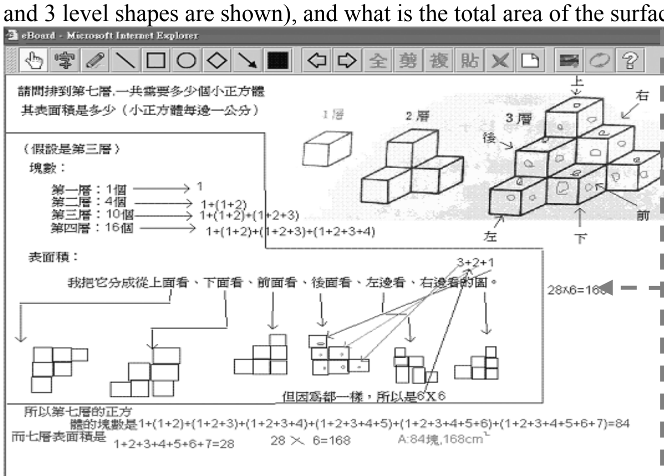


Teacher's comments on the three creative solutions.

Most students can only calculate those numbers that can be seen on the cube. However, they have great difficulty on calculating the numbers that are hiding behind the cube.

This genius student expanded the cube into a two dimensional shape such that all six surfaces can be seen clearly with the corresponding numbers on it. The student even figured out that one group of three surfaces actually has the same numbers and the other group of three surfaces are the same. So, he only needed to calculate two equations and then multiply the sum by 3 to get the final answer. This was really very creative.

Geometric Problem 3: Please calculate how many cubes are needed to form a similar shape with 7 levels (only 1, 2 and 3 level shapes are shown), and what is the total area of the surfaces in this shape.



For those students with less spatial sense and reasoning abilities, they will draw other shapes for levels 4, 5, 6 and 7 and then solve the problem using the 7 level shapes. This way is prone to error as there are too many cubes that cannot be seen.

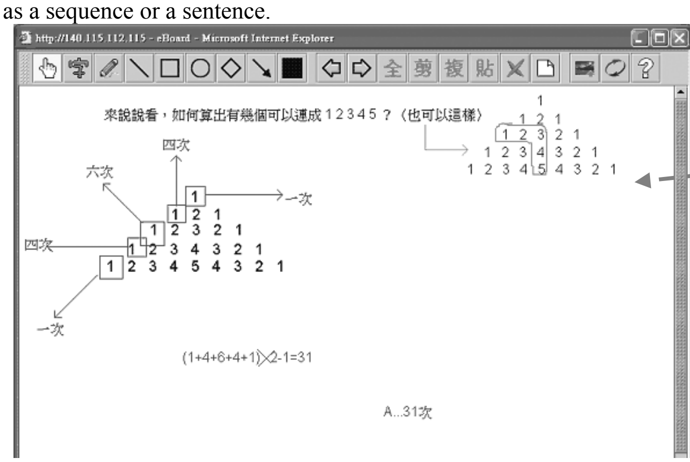
This smart student tried to derive the relationship from levels 1 to 3, and had found the rules between the numbers of cubes required. He then used the rule to infer the required numbers for 7 levels.

To answer the area question, this student used the 3 level shapes to calculate the separate surface area from six different angles. Then, he again used the relation found in 3 levels to infer the total surface area for 7 levels. This solution is excellent, as once the rule has been derived, it can apply to solve any level of n.

Figure 9. Excellent solutions made by students using the multimedia whiteboard system

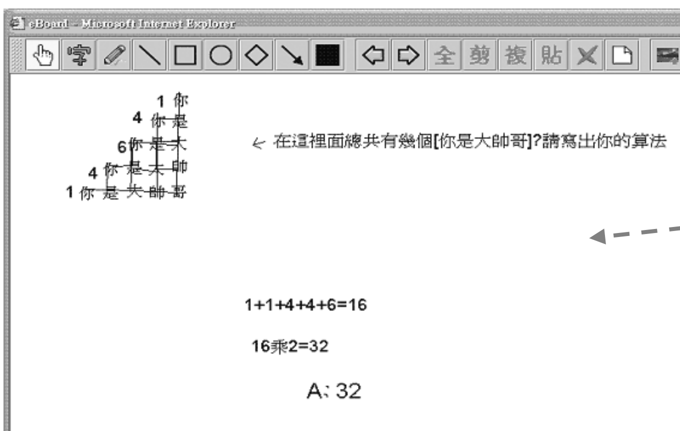
When using the multimedia whiteboard system, the students can be stimulated to try their best to solve problems actively, so that several innovative and excellent solutions could be generated. Many students do not use just the known formula to solve a problem but also derive fantastic solutions using their reasoning and creative thinking abilities. For example, the teachers found several excellent works in the geometric problems as shown in Figure 9. Sung (2005) also pointed out that the peer evaluation 7mechanism should be employed for helping students to understand the problem's properties and to reexamine their own solutions, which then strengthen students' critical thinking and creativity.

Numeral Problem 5: Students were asked to write 5 serial numbers or a 5-words Chinese sentence in the form of a triangle, please calculate how many possible paths can be linked together such that the numbers, or words are connected as a sequence or a sentence.



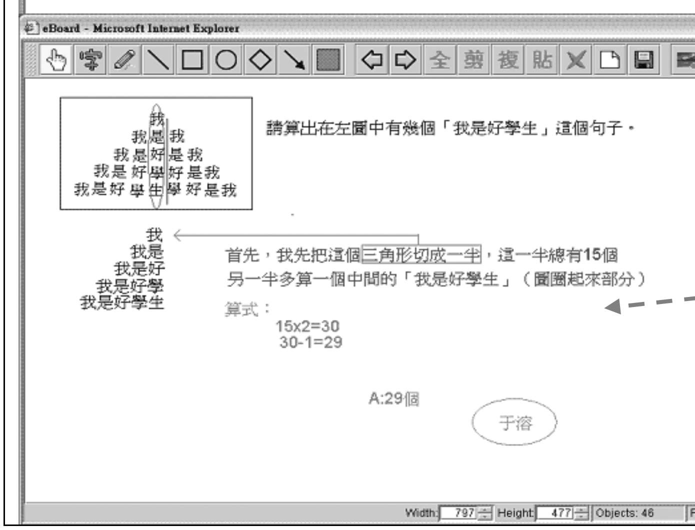
Teacher's comments on a correct solution

This is a correct solution. The student cut the numbers from the middle and then he calculated the possible paths from each number 1 in the left part. Finally, the left sum multiplied by 2 and subtracted 1, because the middle paths had been counted twice. Only 15 students (60%) got correct answers for this problem.



Teacher's comments on a wrong solution 1

This student's solution was similar to the above one, but the mistake was that he forgot to subtract 1.
Only 2 students (8%) had this kind of mistake in this problem.

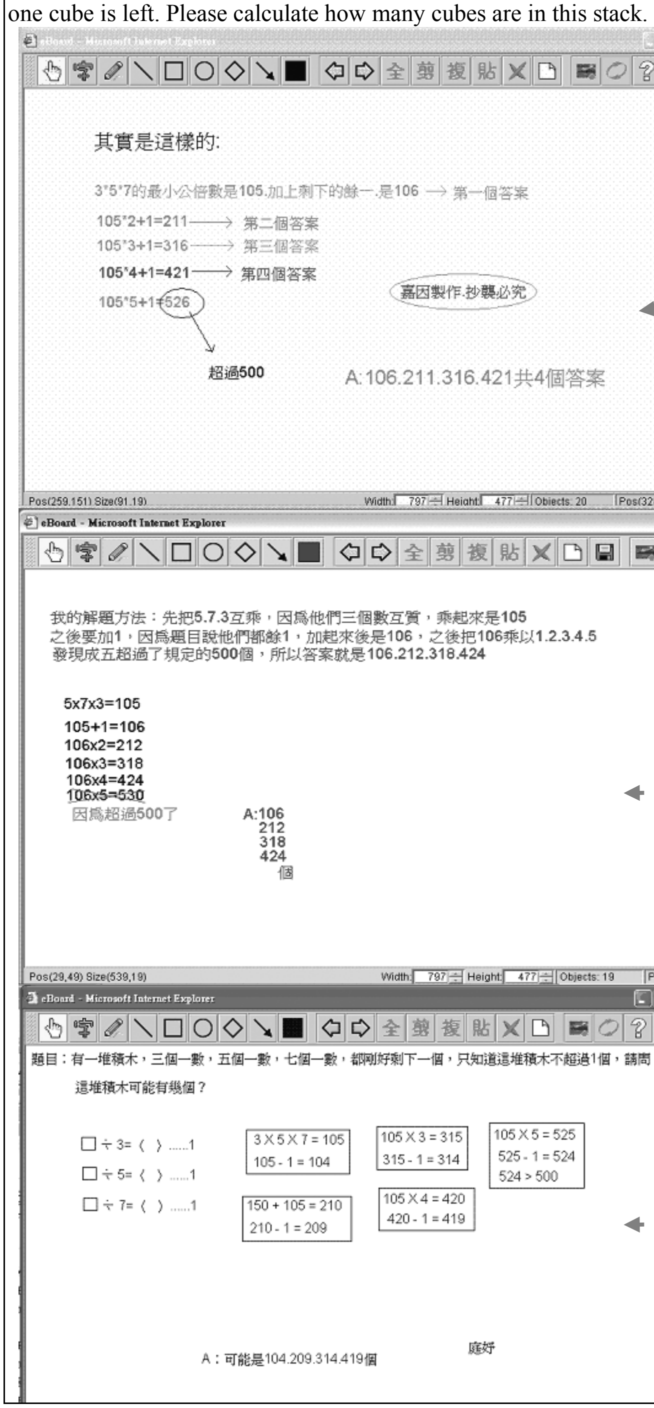


Teacher's comments on a wrong solution 2

This student had the correct reasoning toward the problem, but the mistake occurred on the miscounting one for level 3, after multiplied by 2, the answer became less 2 comparing to the correct answer. There were 6 students (24%) had this kind of mistake in this problem.

Figure 10. Types of mistakes made in Numeric Problem 5

Numeral Problem 7: There is a stack of cubes less than 500, of which if the cubes are grouped by 3, 5 or 7, then only one cube is left. Please calculate how many cubes are in this stack.



Teacher's comments on a correct solution

Most students know that they need to calculate the least common multiplier (l. c. m) of 3, 5, and 7, which is 105 first. Then by adding 1 equals to 106. As this number is still far smaller than 500, so continue to multiple 105 by 2, 3, 4 and 5, the last time will get a value 525 larger than 500. Therefore, there are 4 possible answers for this problem. Up to 20 students (80%) got correct answers for this problem.

Teacher's comment on a wrong solution 1

This student got the first correct answer 106 by adding 1 to 105(l.c.m), He, however, made a mistake by multiplying the first answer 106 instead of 105 with 2, 3, 4 to get the other three wrong answers.. There were 3 students (12%) having this kind of mistake for this problem.

Teacher's comment on a wrong solution 2

This student did not really understand the meaning of remaining 1 in the problem. So, he subtracted 105 by 1 instead of added 105 by 1. Only 2 students (8%) had this kind of mistake for this problem.

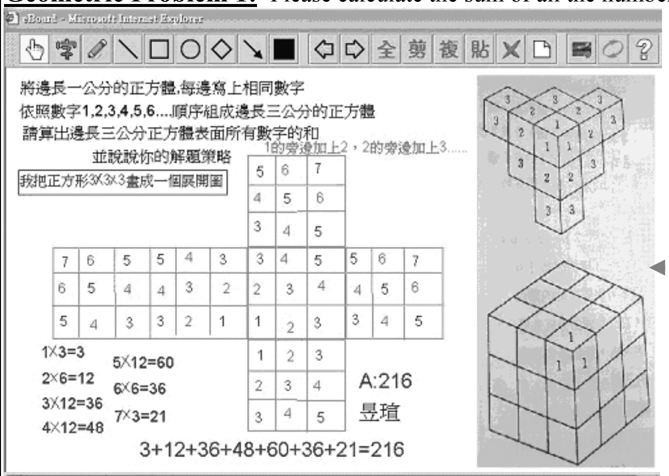
Figure 11. Types of mistakes made in Numeric Problem 7

4.6 Detecting Students' Misunderstanding

Using the Multimedia Whiteboard System to facilitate students learning mathematical problem solving can stimulate students to generate more creative solutions and also help teachers detect what kind of mistakes students might make. The teachers have found several types of mistakes that students often made in numerical and geometric problem solving. Some of the critical mistakes are shown in Figures 10, 11, 12 and 13. By analyzing the mistaken solutions, the teacher can know exactly where the students made mistakes and what caused the misconception. This allows the teacher to give better comments and suggestions accordingly. The teacher also evaluated and improved their class instructions according to the lessons learned in this mathematical problem solving experiment.

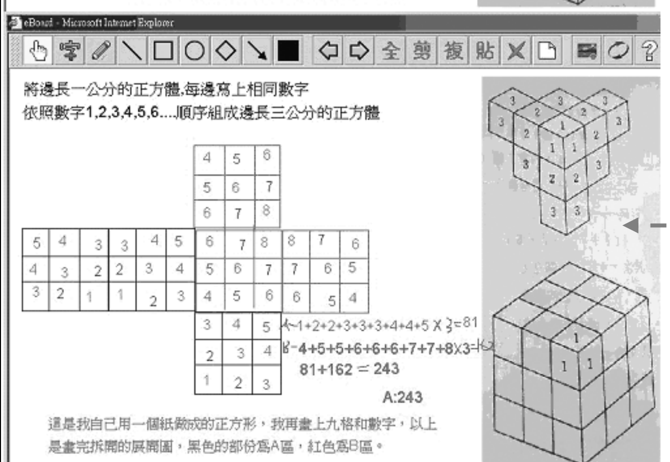
Students were better facilitated in applying their solution methods using the multimedia whiteboard system. For example, in Numeric Problem 5, a student used different colors to draw the sequences such that he would not recount the middle column numbers as those numbers have been counted already in the left part. This would reduce the chance of making a mistake.

Geometric Problem 1: Please calculate the sum of all the numbers shown on the 3x3 cube.



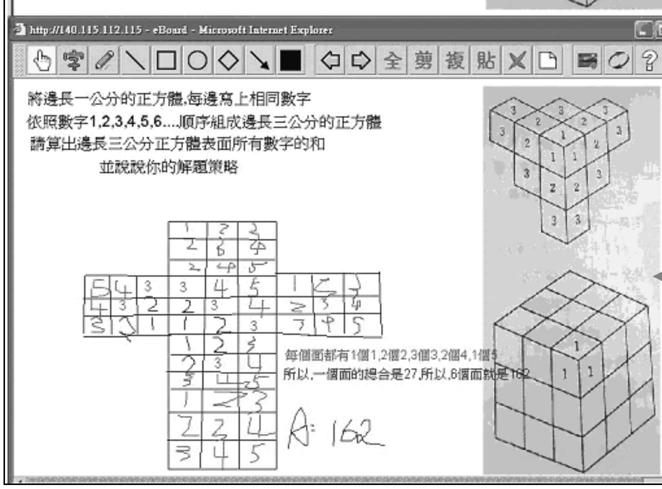
Teacher's comments on a correct solution

This student expanded the cube into a two dimensional shape such that all six surfaces could be clearly seen with corresponding numbers on it. She counted the numbers of 1, 2, 3, 4, 5, 6, and 7 respectively, then all the calculated numbers were summed up together to get the final answer. Up to 22 students (88%) got the correct answers for this problem.



Teacher's comments on a wrong solution 1

This student also expanded the cube, but he did not begin from 1 to fill the cells so all the sequences were wrong. There were 2 students (8%) had this kind of mistake for this problem.

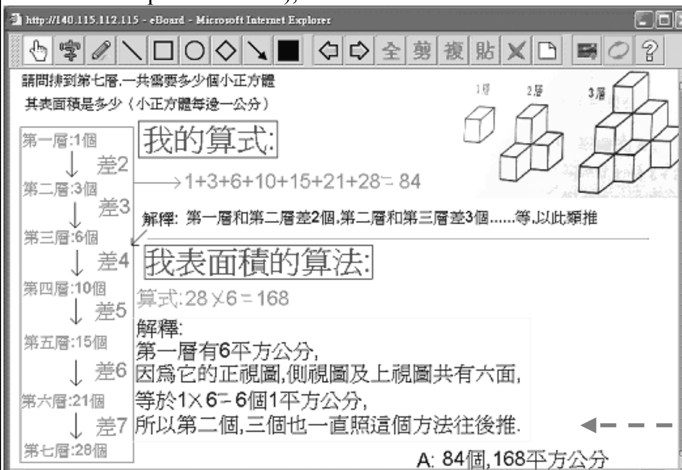


Teacher's comments on a wrong solution 2

The student misunderstood the sequence of the numbers on the cube. When he filled the cells on the expanded shape, the numbers were wrong. Only this student made in this type of mistake.

Figure 12. Types of mistakes made in Geometric Problem 1

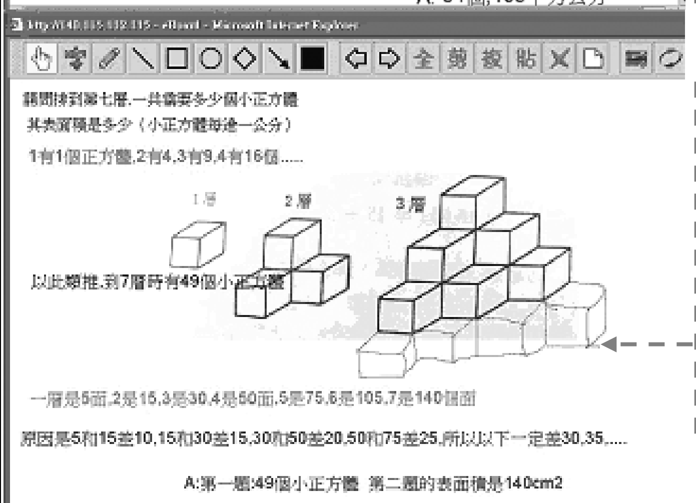
Geometric Problem 3: Please calculate how many cubes are needed to form a similar shape with 7 levels (only 1, 2 and 3 level shapes are shown), and what is the total area of the surfaces in this shape.



Teacher's comments on a correct solution

This student found the differences for number of cubes between levels 1, 2, and 3, then he inferred the differences for other levels, and the numbers cubes needed at each level. Finally, all the numbers at each level were added up to get the final answer.

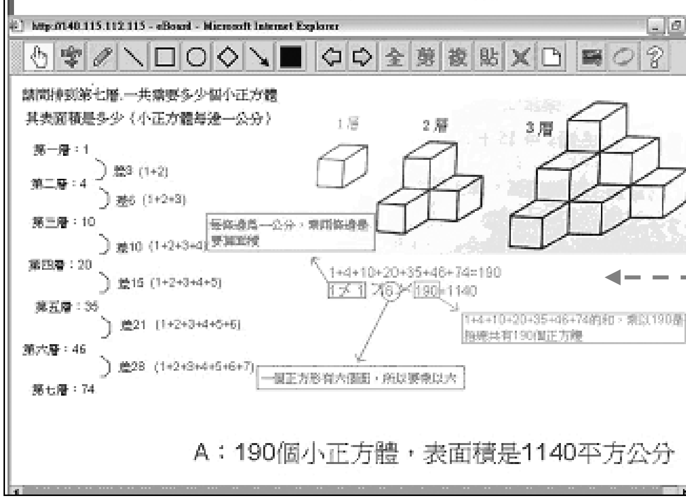
For the surface area of the shape, the student found that the area of all six dimensions was the same as the number multiplying with 1 cm^2. Therefore, the area is equal to the cube numbers multiplying with 6 cm^2. Up to 23 students (92%) got the correct answers for this problem



Teacher's comments on a wrong solution 1

This student got the right number of cubes for level 1 and level 2, but was incorrect for the third level. The number he got was 9 (10 is the correct answer). Therefore he inferred the number of cubes needed is equal to the square of level (7 X 7 = 49).

He also missed the bottom side so the answer was also wrong. Only this student made this type of mistake.



Teacher's comment on a wrong solution 2

This student made a mistake by putting the total number of cubes for the third level as the number of cubes for only level 3. For example, he put 10 (1 + 3 + 6) as the number of cubes for level 3, but 6 is the right answer. Consequently, the area of surface was also wrong. Only this student made this type of mistake

Figure 13. Types of mistakes made in Geometric Problem 3

5. Conclusions & Suggestions

This study explored how multiple representation skills and creativity affect mathematical problem solving using a multimedia whiteboard system. We summarize the main findings according to the proposed three research questions.

5.1 Representation Skills of T and G Are the Keys to Mathematical Problem Solving

Most students could easily apply formulas to get their first solution without any detailed explanation. However, many students obtained good solutions with enhanced T and G representation skills after participating in the criticism and response activities. Only a few students could not do it after this. We classified students into 'Balanced Group' and 'Unbalanced Group' according to their representation skills. The student performance in using representation skill R between the two groups was not different. However, the Balanced Group students performed significantly better than the Unbalanced Group students on representation skills T and G. This finding matches the revised Bloom cognitive taxonomy for the six levels of cognition process, that is 'remembering', 'understanding', 'applying', 'analyzing', 'evaluation', and 'creating'. In this study, the students not only carried with 'remembering', and 'applying' but also 'understanding' the problems and the formulas by elaboration to their solution. Once the students used multiple representations like text, voice, symbol and graph to explain their solutions, the teacher could further investigate whether students really 'understood and applied' or merely 'remembered' the formulas. Therefore, the T and G representation skills play the most important roles in linking the learning process among 'remembering', 'understanding' and 'applying'. We conclude that T and G representation skills are the keys to successful mathematical problem solving for students.

5.2 Profound Effect of Elaboration Ability in Creativity on Multiple Representation Skills

The elaboration ability of students is very essential for them to be able to elaborate their own solutions or to criticize others' solutions using various methods and perspectives. In the Williams' creativity test analysis, elaboration ability is the key factor that stimulates students to create their own knowledge during a problem solving process. The students with high elaboration ability could manipulate T and G representation skills well in problem solving. Students with high elaboration ability could take better advantages of peer interactions and teacher guidance to generate more diversified ideas and solutions in problem solving. In contrast, students with low elaboration ability had great difficulty in manipulating their representation skills well. We conclude that elaboration ability in creativity is one of the critical factors that affects student multiple T and G representation skills in mathematical problem solving.

5.3 Advantages and Disadvantages of Using Multimedia Whiteboard in Mathematical Problem Solving□

Applying multiple representation skills to solve mathematical problems using the designed multimedia whiteboard system with mutual criticism was helpful in stimulating students with prosperous perspectives on problem solving and criticizing. In the face-to-face classroom, most students follow only the approach that the teacher teaches in class. They seldom try to follow their own ideas and approaches to solve math problems. It is not easy to stimulate students to use multiple representations in math problem solving and explaining. However, in this study, it was shown from teachers' observations that the students enjoyed using the multimedia whiteboard and felt it was very interesting and useful for them to solve mathematical problems. Therefore, they were highly engaged in problem solving in the computer classroom. Even in the criticism activity, they paid good attention to giving comments to others. When the students explained their solutions, criticized others' solutions and responded to others' comments using text, voice, graph, or symbol, they had the chance to reflect on whether they really understood the problem. The teachers were able to identify students that misunderstood points in each component of problem solving, and provide immediate assistance and suggestions.

One drawback of the designed multimedia whiteboard system is that it only provides mouse, keyboard, or microphone as input devices. Students might get frustrated using a mouse to draw mathematical symbols or graphics. Adopting a tablet PC or digital ink technology might solve this problem.

5.4 Suggestions

To cultivate students' critical thinking and reasoning ability through mathematical problem solving is essential. Students multiple representation skills must be stimulated and applied for explanation and criticism in the problem solving process. Due to the time and tool limitations in the physical classroom, ICT tools should be adopted to support students while applying multiple representation skills to mathematical problem solving. The designed web-based multimedia whiteboard system can better facilitate students in giving multiple representations during mutual criticism. It is also recommended that teachers design mathematical problem solving activities supported by multimedia whiteboard systems to improve students' multiple representation skills. Regarding future study related to creativity, the affective factors in Williams' Creativity test, like curiosity, imagination, challenge, and risk-taking that were not addressed in this paper, are worth further study.

Acknowledgment

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Distance Education Techniques to assist skills of Tourist Guides

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ABSTRACT

This study is a presentation of the usage of distance education technologies in a bid to support face to face education of tourist guide candidates during the training tour. The laws require tourist guide candidates to successfully complete their internship tour and get a certificate. Since the time in this internship period is limited and there are restricting factors such as transportation, accommodation; many of the tourism places couldn't be included in this internship period. Besides, the lack of experienced and competent guides in the visited places is also another negative factor reducing the quality and efficiency of the training. Technological support of the training of tourist guide candidates would effectively reduce the negativities of traditional education methods. Thus, benefiting from computer technologies and audiovisual systems during the internship of tourist guide candidates would result in an increase in the effectiveness and usefulness of the training tour and would make it possible to visit more places in a shorter period. This study is a presentation on how distance education method could be implemented and an attempt to show the benefits could be obtained from implementation of these methods along with the possible problems that are predicted to arise.

Keywords

Tour guiding, Distance education, Information sharing, Technology aided education

Introduction

Tour guiding requires professional background knowledge especially in some specific tourism places. Along with the university education, experience is also a must for the appropriation of the information learned in that education period. The first step towards the professionalism is the obligatory training tour of guiding (i.e. internship) that is conducted before the graduation from the university (Turkish Ministry of Tourism and Culture, 2006; Boz, 2004). The training tour has therefore a very fundamental role.

Tourist Guides would play a decisive role in holiday makers' satisfaction from their holiday experiences and in providing a good country image in the minds of foreign visitors and in promotion of countries' tourism potential. A good practice of this role would bring both individual and public benefits.

With the start of the usage of distance education system, the education system became more effective due to the reduction in costs and required time. Usage of distance education systems becomes more widespread with the developments in technology. In some cases usage of distance education systems has become a necessity. Despite that distance education system introduces new costs to budget in the beginning; these costs will lessen the overall expenses of the education in the long run (Keegan, 2004).

Notwithstanding that the idea of using distance education techniques in the field of tourism, this idea couldn't yet resonate with the practice sufficiently. Using the distance education models proposed in this study in the training of tour guides, would result in an increase in the quality of the education (Balta & Sahin, 2006).

Motivation

Keeping in mind that tour guide candidates would play a very significant role in the promotion of countries, it could well be expected that they should have a vast knowledge on various fields. The tour guide training would therefore be conducted to ensure tour guides' appropriation of such a vast knowledge. In this regard, like in many other countries, there is an obligatory traineeship period that should last at least 36 days. This training requires visiting of many tourism places all across the country (i.e. approx. 11,000 km.) in 36 days and gaining accurate and adequate knowledge about the places visited.

Success of tour management usually is regarded as depending on two factors: The first factor is the planning of tour with keeping in mind the unexpected events. The other factor is the competence of a tour guide that has strong leadership capacities and good communication skills (Fay, 1992). Furthermore, tour managers and especially the tour guides have to have very strong background information and should be subjected to a multi-disciplinary education (Ahipasaoglu, 1997). Due to the age factor, some of the specialists, experienced guides (according to the tourism guide regulations in Turkey, the guides that is to give training to tour guide candidates should have at least 8 years of experience) and instructors (as required by laws) couldn't be able to participate in some stages of tours. The large number of the places that should necessarily be visited during the tour is also a complicating factor since it requires a high stamina, healthiness and high physical power. Adding to this the conditions of force majeure, it became further difficult to ensure full and effective participation of specialists in the tours (Ozbay, 2002). Using distance education systems in tour guide training in order to ensure candidates benefiting from the experiences of experienced tour guides and instructors would be very important in increasing the effectiveness of the training. It would thus become possible for tour guide candidates to benefit from training by experienced personnel without requiring those personnel to participate in the tour in person. It would also be possible for the experts to participate in training of more than one group in subsequent times.

Due to the requirements of the law, internship (training tour) should be conducted without any interruption (Turkish Ministry of Tourism and Culture, 2006). The laws do not allow the candidate guide to quit internship for any particular reason or to have a break in the internship term. In case of any quitting or giving a break to internship, the whole period of internship should be conducted again. When considered that each university can carry out only one internship program during one academic term, the candidates who have to redo internship would have to wait for one year to carry out the same training and that is a loss of one year. Sometimes candidates had to give a break within the internship period due to reasons as casual traumas (arm, leg etc.), insect bites, psychological problems or intense fatigue. By means of distance education techniques, candidates experiencing such problems could follow the training program for short temporary periods of two or three days and thus they could be enabled to complete the training without any interruption.

Spreading of education would make it possible further participation of guide candidates even before lower classes and would result in relative widening of training period. Candidates' obtaining information on the places to be visited during the internship period before they set out for visit and their learning from the experiences of experts would be beneficial in increasing the success to be obtained from the tour. It would therefore be very beneficial for tour guide candidates to learn about the tour via techniques of distance learning before they set out for tour and while they were in their schools, laboratories or even at their homes. It would thus be easier for students to firm up their knowledge on the tour with the information they got from the experiences of the previous terms in advance. Besides, these techniques would also be beneficial for experts and instructors who would want to refresh and update their knowledge.

Distance education techniques would also enable recording of training environment and would allow the documents, audio-visual files to be saved and archived. It would then become possible to revise the information which is thought to be perfect and complete. These recordings could also be used to establish Tourism Information System (TIS), which could be a further work on these recordings. In addition to all of these benefits, it would also contribute candidates' appropriation of information regarding the tourism resources that lies far beyond the scope of a 36 days training travel of almost 11,000 km and it would therefore become easier to get information about the places that it is difficult to reach due to budget and time restrictions.

Related Works

The use of information technology in tourism sector was the focus of many researchers and institutions and there have been various successful examples of implementation in this field (Poon, 1988; Buhalis, 1998; Ozturna & Roney, 2004). Among the first studies in this field, there is the work of Poon (1998) named *Tourism and Information*

Technologies. Beginning with this study, information technologies were started to be used in tourism sector in a general manner. Following these studies, seminars, conferences and symposiums were organized annually for the development of this sector.

On the other hand distance education is also widely used in the field of Tourism Management and Hospitality. Almost all of the implementations in this field were focused on Tourism Business and Hospitality Management (The Professional Development Institute of Tourism, 2006; Indira Gandhi National Open University, 2006; ACS, 2006; Indiana University, 2006; New Nouveau Brunswick, 2006; University of Guelph, 2006; NC State University, 2006; University of Houston, 2006; Southwestern University, 2006; Les Roches Swiss Hotel, 2006). The universities that carried out these implementations have started to implement distance education techniques on courses of tour guides. However, since these implementations were carried out towards specific courses, they remained only limited to the features of the courses.

Usage of distance education techniques have not been investigated adequately since it is very much important in the field of tour guiding to see the places of visit on site and to get a face to face education. The aim of this study is not to remove face-to-face education but to establish a stronger training mechanism by supporting traditional education by distance education techniques. The aim is therefore to establish a more effective education period by combining the traditional education methods that require candidates' and instructors' being on site in person with distance education techniques.

The above mentioned studies are only some examples that are carried out in this field. All of these sample works are only the visible part of the iceberg, because there are innumerable works in this field. However, the most important factor in these studies is that they do not envisage using distance education techniques in the phase of tour guide education. What is different in this study from many of the other studies is that it aims to establish a supportive environment for providing the gaining mentioned in motivation section. Thus a new training process as a new implementation would be provided.

When considered from a technological point of view it could be said that using mobile technological devices have caused a more effective information sharing mechanism (Kimber et al., 2005). In addition to these benefits, there have been also some works for the optimization of the road of travelers' tour destinations and decision making process were developed by using genetic algorithms, linear programming and artificial intelligence (Taplin & Qui, 1997; Sirakaya, 2005). Works that would be carried out through aid of mobile devices would be more efficient and would require less infrastructure cost.

Distance Education in Tourism Guidance Training

Distance education

Distance education is a system that is used to bring together students and instructors via technological means and in an interactive manner in order to provide continuous training (Keegan, 1986). It is also used to support a collaborative work and to provide a more efficient education by enabling more participation in the training (O'Malley & Scanlon, 1990). Additionally, these systems would also be beneficial for students that are working or those that have difficulty in transportation.

The materials that could be used in distance education would range from printed materials to TV and to interactive technological education tools. The basic problem with Radio and TV broadcasts is that these mediums do not allow two-sided communication (Sherry, 1996). It is for this reason that computer and Web based technologies had become very effective in distance education process. A general description of distance education model, which is understood as bringing together of physically distant points in virtual environment, could be seen in Figure 1 (Bulbul et al., 2003). These distance education techniques assisted by computer technologies enable to construct interactive and bi-directional education system.

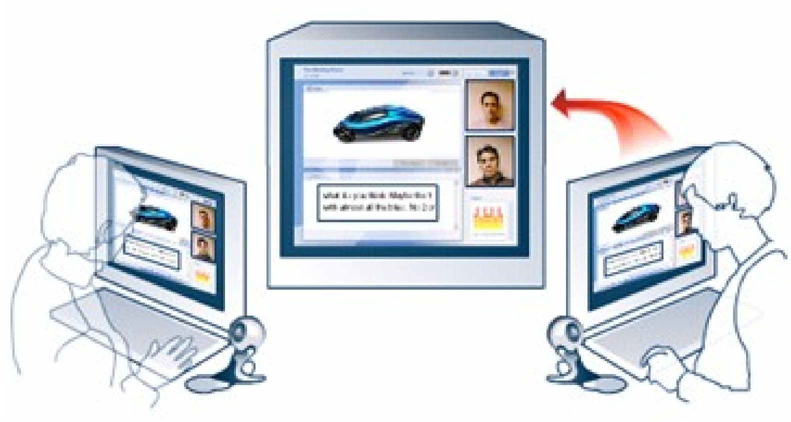

Figure 1. Elementary structure of Distance Education

A standard method of distance education system is home, office or desktop applications. Application of a distance education system would require a more complicated structure when they are prepared towards travelers. The most important factor in this infrastructure is the usage of mobile technology devices. With the advent of technology in the recent years, service area of the mobile technological devices has become covering almost all destinations in a country. Keeping in mind this opportunity provided by mobile devices which are now an important component of distance education, it became possible to continue education while traveling along with the general desktop applications. The distance education models and the materials to be used in these models are shown in simple form in Table 1 (Taylor, 2000). Since tour guide education requires the guide candidate to see the tourism sites, the distance education model to be used in this field of training should be fully flexible, bi-directional and lowest-cost. The 5th generation intelligent models shown in Table 1 are the most adequate systems to be used in this field of education.

Table 1. Models of Distance Education

Models of Distance Education and Associated Delivery Technologies	Characteristics of Delivery Technologies: Flexibility				Institutional Variable Costs Approaching Zero
	Time	Place	Pace	Advanced Interact. Delivery	
1st Generation - The Correspondence Model					
• Print	Yes	Yes	Yes	No	No
2nd Generation - The Multi-media Model					
• Print	Yes	Yes	Yes	No	No
• Audiotape	Yes	Yes	Yes	No	No
• Videotape	Yes	Yes	Yes	No	No
• Computer-based learning (CML/CAL)	Yes	Yes	Yes	Yes	No
• Interactive video (disk and tape)	Yes	Yes	Yes	Yes	No
3rd Generation - The Tele-learning Model					
• Audio-Tele-conferencing	No	No	No	Yes	No
• Video-conferencing	No	No	No	Yes	No
• Audio-graphic Communication	No	No	No	Yes	No
• Broadcast TV/Radio and Audio-Tele-conferencing	No	No	No	Yes	No
4th Generation - The Flexible Learning Model					
Interactive multimedia (IMM)	Yes	Yes	Yes	Yes	Yes
Internet-based access to WWW resources	Yes	Yes	Yes	Yes	Yes
Computer mediated communication	Yes	Yes	Yes	Yes	No
5th Generation - The Intelligent Flexible Learning Model					
Interactive multimedia (IMM)	Yes	Yes	Yes	Yes	Yes
Internet-based access to WWW resources	Yes	Yes	Yes	Yes	Yes
Computer mediated communication, using	Yes	Yes	Yes	Yes	Yes

automated response systems.					
Mobile Devices (e.g. GPRS, 3G, etc.)	Yes	Yes	Yes	Yes	Yes

Communication Methods

It is possible to choose the communication technology to be used in the system in accordance with the field that the model is to be used. It would be beneficial to use printed materials along with the products that could be used to support systems mentioned as 5th generation. Products and usage methods are as follows:

- Mobil phones (GPRS, 3G),
- Notebook computers with Internet connections (Wireless)
- TV-Radio broadcasts
- Printed materials, Slide shows

Figure 2 shows the technological infrastructure of the system. It is possible to use all of the above mentioned technological devices in this system. The necessary mechanisms that are necessary to establish the necessary infrastructure is used in almost all of the countries in the world. It is possible to use any of the mentioned technologies in the infrastructure in accordance with the conditions at the destination (physical conditions, level of development, etc.). It would thus be possible to get benefits from more than one kind of product and from as much as possible methods.

The interactive education material to be used in the tour in Turkey would differ from region to region due to some technological limitations. The most important reasons for this are that some technological products are not yet became widespread in some regions and that physical conditions of some regions do not allow usage of some kind of technologies. The interactive education materials to be used in this study are gathered in three main parts. Within the first part of these education materials are mobile phones (3G, mobile phones that allow GPRS support, PDAs and PALM computers), notebook computers with internet connection over EGDE, PSTN or ADSL technologies and online connections via television and radio signals.

Mobile Phones

The developments in mobile phone technologies made it possible these technologies to be used in many fields (Dung, 2002). Especially the invention of GPRS (General Packet Radio Service) and 3G (Third Generation) technologies have made it possible to connect to internet and to conduct audio visual conference communications via mobile phones. The most important feature of these technologies is that they allow benefiting from these services from almost all destinations with the exception of some blind spots. By using the GPRS technology it became possible to access internet and carry out some transactions via internet from almost any place by means of a mobile phone or notebook computer. The 3G technology which has been recently developed, and becoming widespread everyday allows carrying out visual and audio conference communications. Since the usage of this technology in the tourism sector would not require an infrastructure cost (almost all students are having a 3G supported mobile phone), it would be a very advantageous system in implementation.

Notebooks and Laptops connected to Internet

Mobile phone services (GPRS, EDGE), PSTN and mobile computers (notebook, laptop etc.) that can access to internet via technologies as (Telephone Network, Wireless) and ADSL could be used in almost anywhere that in the service area of these technologies. Besides that they could be used for internet services, these computers could also be used for audio-visual communication purposes. These computers, which could be used for internet services, could also be used for audio-visual communication purposes. They are also frequently used in distance education technologies (Bulbul et al., 2004). These computer systems both provide easiness for establishing firewalls and could be used as education tools since they allow free development of software. Furthermore, establishment of such a system requires very easy and inexpensive process.

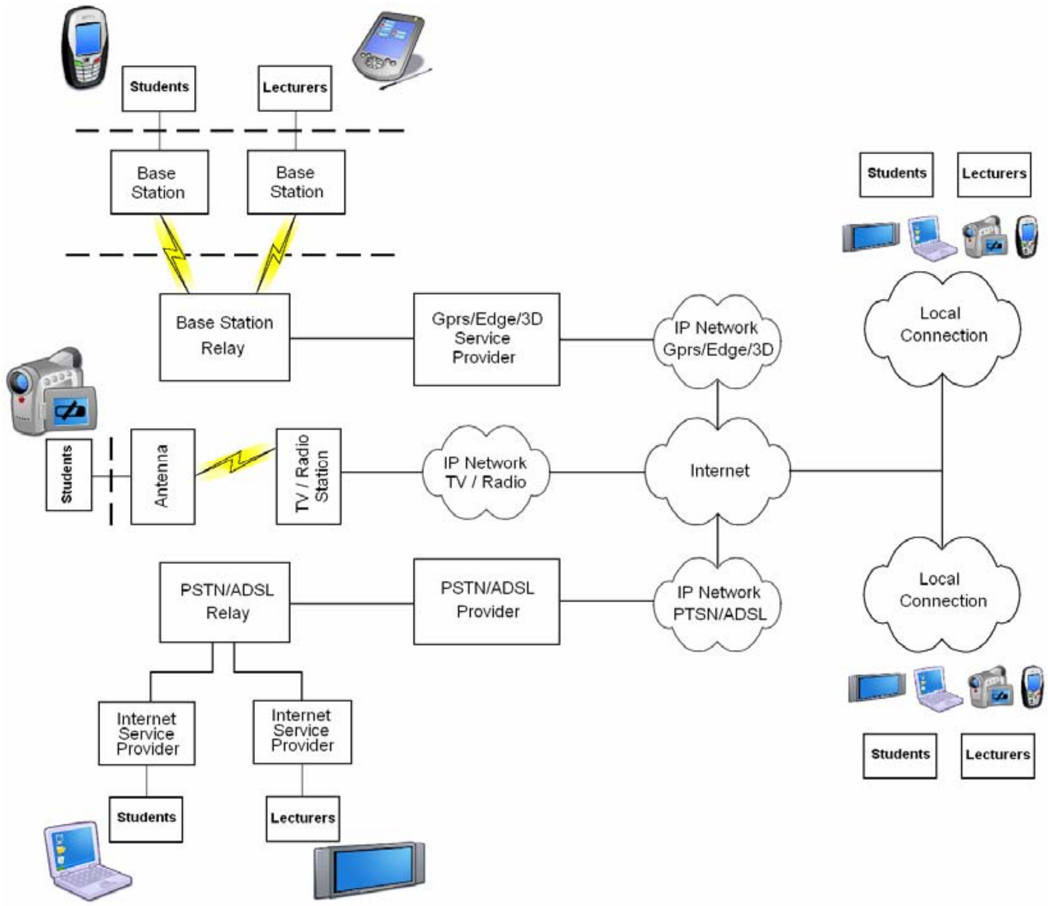

Figure 2. Technological infrastructure of Distance Education for tourist guide training

TV and Radio Broadcasts

Distance education model through TV and Radio broadcasts has been using widely since a long time. Television and Radio programs that are launched in support of printed materials under the framework of a distance education system has been developed with the collaboration of education technocrats and experienced technical teams by using advanced technical opportunities. Television and radio programs are prepared for the issues that are chosen from within the printed materials by editors, scriptwriters and directors. Following steps are scriptwriting, production of programs and their broadcast (Anadolu University, 2006). However, this requires allocating of a TV or Radio channel just for a specific target group and would be a very expensive and difficult process. It is therefore a system that is very difficult to implement.

Printed Materials and Others

This system has been using at the present. All candidates are given such kind of materials in advance of the internship period in a bid to contribute their training. However, the most important disadvantage of this system is that it is not interactive and has no mechanism that allows it to respond to the questions of users. Moreover, it would require planning of a tour in a bid to reach a system and it would require much time and work for revising the parts that could cause any unpredicted technical problems.

The choice of technologies that would be used here are totally depending on the technical and physical adequacy of the tour destination. Mobile telephones and PDA computers would mostly be chosen in the places within the service area of GPRS, EDGE and 3G technologies for the convenience they provide. However, the point that the attention should be paid here is that the video streaming speed should be adequate and that it should not cause any interruption during the education process. In such cases especially when 3G and EDGE services are too slow to be used in distance education system, other connection methods as PSTN or ADSL should be used through mobile computers. Likewise, ADSL connection is available for use in the regions that are out of the service area of mobile phones. And in cases, when both services are unavailable, TV and Radio broadcasts could be used as a support for training either live or in pre-recorded form. In cases when the data transfer speed is not enough for visual data transfers, transfer of interactive audio data should be selected. Moreover, when devices used as tools of distance education are capable of wireless communication it would further contribute to the continuance of education by providing flexibility to movement.

Implementation of Distance Education techniques in guidance training

The interactive usage of distance education technologies that provide lack of restriction with respect to education space offers more convenience for conduction education. Two main topics of education and 4 different scenarios were considered in the proposed method. First of the main topics is, the education of students away at the destination through distance education system by experts that are away from the site; and the other one is that the education of students in their homes or schools through distance education systems by the experts that are on site. The materials and education systems to be used in interactive education in both systems are the same in both of the systems.

Figure 3 shows the model that is proposed to be used in internship training of tour guide candidates. The destinations shown at the left side (a) of the Figure indicates the places that guide candidates and trainers are in and the right side (b) indicates the candidates and trainers that are away from the place of visits and the destinations shown in the middle (c) of the Figure indicates the communication devices. The possible scenarios that could be used in this model to support education are as follows:

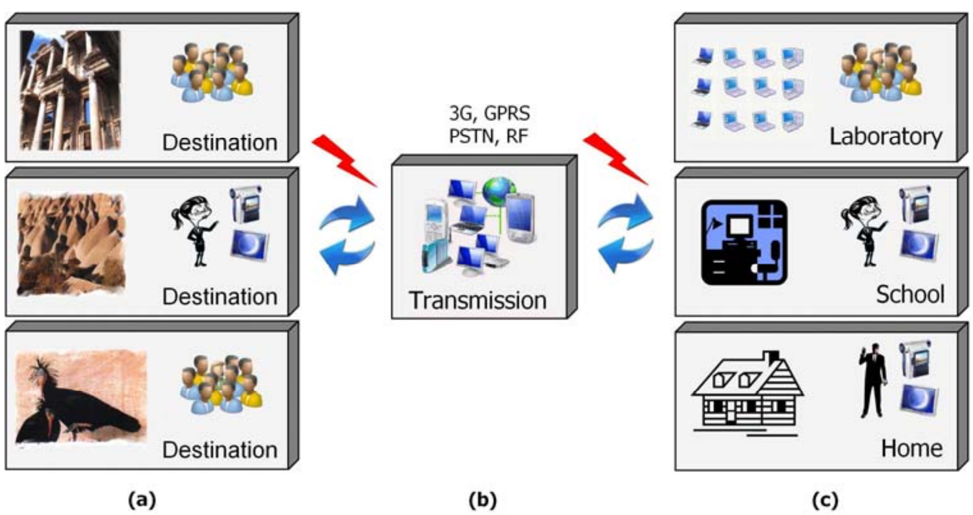

Figure 3. Distance Education model in Tourism Guidance

Scenario 1 (1:1) : Completion of the information process through interactive connection of one instructor who is at the school or at his or her home (c) while the tour guide candidates are at the destination (a). Example: A group of candidates at the destination of (a) could be informed about the Ephesus Ancient City from a guide who is with them in person and at a subsequent time they could get a more detailed information for a duration of 15 to 20 minutes about the architectural structure and artistic importance of the ancient city from an art historian at the destination (c). This scenario removes the necessity of the instructor's visiting the Ephesus Ancient City and thus results in lower costs and a gain in time.

Scenario 2 (1:N) : Completion of the information process through interactive connection with more than one expert from the school or while they are at their homes (c) when the tour guide candidates are at the destination (a). In this case it would also be possible for the other candidates (or other relevant people) that are in the laboratories to participate in the training. Example: A group of candidates at the destination of (a) could be informed about the Ephesus Ancient City from a guide who is with them in person and at a subsequent time they could get a more detailed information for a duration of 30 to 40 minutes about the architectural structure, archeological history of the ancient city from a art historian at the destination (c) and from an architect or archeologist at the destination (c). Some other candidates that cannot, for any particular reason, participate in the tour in person could benefit from those information at the destination (c). This scenario removes the necessity of two instructors' visiting the Ephesus Ancient City and thus results in lower costs and a gain in time.

Scenario 3 (M:1) : Completion of the information process through interactive connection with an expert from the school or while they are at their homes (c) when more than one group of tour guide candidates are at the destination (a). This situation also allows participation of another expert to the training at a different destination (c) and would contribute to a more efficient information sharing. Example: A group of candidates in the Ephesus Ancient City (a) could be concurrently informed about the history of Hellas and Rome at the same time with another group of guide candidates at the Selcuk Ephesus Museum via an interactive connection with a Rome historian at the destination (c). There is a great amount of gain from time since one instructor can give information to two different groups simultaneously. It would also be beneficial in the sense of the effective usage of inadequate number of experts by enabling them to instruct to two different groups.

Scenario 4 (M:N) : Completion of the information process through interactive connection with more than one expert from the school or while they are at their homes (c) when more than one group of tour guide candidates are at the destinations (a). This scenario provides a full distribution of interaction and establishes a global education mechanism. It enables the interaction of guide candidates and instructors at the destinations (a) and of guide candidates and instructors at the destinations (c) to the same education environment. Example: All tour guide candidates at destinations (a) and (c) could get information on professional ethics and the on job information about the profession and could learn from the experiences of experts and instructors at destinations (a) and (c).

Experimental Results

An experimental study has been carried out in order to measure the effectiveness of the present research. The experimental tour conducted in the research was comprised of places of visit and number of candidates in a bid to simulate the real internship tour around Turkey (in order to keep the training efficient, at most 40 students are allowed to participate in the real tour). This tour is conducted in two stages. In the first stage, 30 students, which is the control group, were trained with traditional education methods without using any distance education technologies; and in the second stage a group of another 30 students, which is the experimental group, were trained by using distance education techniques.

Table 2. Experimental tour' information

Destination	Visiting Duration (min)	Devices and Software which are used for education	Given Information
Isabey Mosque	30	GSM, GPRS – Skype	Architecture, History of Art
Ephesus Ancient City	60	EDGE, GSM – Skype	Architecture, History of Art, Archeology, Anthropology
Virgin Marry House	30	GSM, GPRS – Skype	Architecture, History of Art, Christian's Revolution
St. John Basilica	30	GSM, GPRS – Skype	Architecture, History of Art, Christian's Revolution
Ephesus Museum	60	Wireless Lan, ADSL – Skype, VCPtoP	History of Art, Archeology

Table 2 shows the information relevant to the experimental tour. The experimental group started its visits from Selçuk Isabey Mosque and they were given information about the importance of the Mosque with regard to Turkish and Islamic history along with the information about the historical and architectural information of the mosque. Then the students in the experimental group visited Ephesus Ancient City and they were given information about the history of the ancient city from archeological, anthropological and artistic points of views. The group then visited the

Virgin Mary's house and Ayazma, and was given information about the importance of the place for Christianity. The tour then continued with a visit to St. John's Basilica and the group was about the architectural structure and historical importance of the place with respect to Christianity. The last place that visited was Ephesus Museum where the group was informed about the findings from the Ephesus Ancient City.

Only one guide and one instructor participated in the education of experimental group and the information regarding the architecture, history of art, history, archeology and anthropology was given to the group through distant interactive connections with the specialists of these fields in the university.

At the end of the tour the two groups were subjected to an exam in order to test the efficiency of the education and to observe the difference between two methods. The exam was comprised of 60 questions and was compiled in 4 sections. The sections were divided to measure historical knowledge (15 questions), artistic knowledge (15 questions), visual information (15 questions) and general understanding of the tour (15 questions). Table 3 shows the results of these measurements.

Table 3. Assessment results of experimental tour exam for tourist guide skills

Question Type / Maximum points	Application Group Average	Control Group Average
Ephesus Ancient City, Ephesus Museum		
Historical Skills (Archeological, History of Art.) / 5	**4.04**	**2.53**
Social Skills (Anthropological, Social Structure) / 5	**4.11**	**3.62**
Visual Skills (Architectural, Environmental) / 5	**4.53**	**3.18**
General Culture / 5	**3.83**	**3.90**
Isabey Mosque		
Historical Skills (Archeological, History of Art.) / 5	**4.31**	**3.28**
Social Skills (Anthropological, Social Structure) / 5	**4.27**	**3.19**
Visual Skills (Architectural, Environmental) / 5	**4.78**	**3.76**
General Culture / 5	**4.12**	**4.19**
Virgin Marry House, St. John Basilica		
Historical Skills (Archeological, History of Art.) / 5	**4.42**	**3.13**
Social Skills (Anthropological, Social Structure) / 5	**4.16**	**4.23**
Visual Skills (Architectural, Environmental) / 5	**4.83**	**4.16**
General Culture / 5	**4.31**	**4.27**
Total Cumulative / 60	**51.71**	**43.44**
Total Cumulative / 100	**86.18**	**72.40**

The field information obtained as a result of the exam is shown in Table 3. It could be seen that the rates of success are changing from one field to another. It is for sure that the education levels and fields of interest of the participants is also a factor affecting the result of the exam. However, since both groups of students (experimental and control groups) were selected from the same department of the university, those differences should be regarded at the lowest level.

The exam showed that while the group educated with distance education techniques has obtained an 86.18 success rate in general, the success rate of the control group was remained at 72.40. Looking at these results it could be said that by using the distance education techniques, the success rate of the candidates could be increased by 16% (=86.18 - 72.40 / 86.18).

Another gain that was observed during the experiment was total communication costs that was spent for GPRS, GSM, EDGE and ADSL Technologies are the same amount as the transportation costs that an expert from whom the information is got from distance would spend to reach there. Considering that the infrastructure cost would be spent only for once, it would seem obvious that the communication costs of the technological devices would be much less than the costs that would be necessary for bringing experts to the sites of tours.

Discussion

It has been seen that some important information can be provided for the candidates in a more appropriate and cheap way by the use of distance education system. In addition to this, it has been seen that the time needed for the experts to go to the visit places is lessened and thus they could provide information for more than one group simultaneously and more comfortably. In this way it was observed that significant gains can be obtained in terms of education, time, and cost.

In the studies, some problems were also observed besides the gains. The main problem is that in the regions where technological infrastructure is insufficient, especially EDGE and Wireless LAN technologies are not used (approximately %30 of the visit places are in such conditions) the connections are slow and/or connections is lost time to time affects the education in negative way. Therefore, it was observed that the system requires use of high technological products. In addition to this, the materials that will be used for the education especially visual instruments that the guide candidates and guides use (headphones, microphones) should be wireless. Use of wireless instruments is very important for not only increasing freedom of movement but also preventing disturbance of other visitors in the visit place during education.

It can be concluded that since the beginning infrastructure costs are not too high and high technological products costs less than labor power, use of this system is quite appropriate.

Conclusion

This study is an implementation of distance education model in “Big Training Tour of Turkey” education. As a result of implementation of the suggested method, many positive results and information regarding the validity of the method have been obtained. It became possible to support education of tourist guide through the use of Distance Education techniques. In this way, through use of technological products in education of tourist guide, quality of the education is increased and its cost and duration is decreased. Advantages of this method for the education can be listed as follows:

- A good education is provided in all places in the context of the tour that should be visited within 36 day education period
- It enables carrying out parallel training of more than one group and thus enabling the instructors that have expertise on more than one destination to participate in the training of more than one group in different destinations without visiting the places in person.
- The candidates who cannot participate directly temporarily have the chance to participate in the tour from distance.
- People who do not attend to the tour and want to participate as audience can benefit from the tour information over internet.
- Reducing of the training period by enabling the groups to be benefited from more than one expert at the visited places of the tour and thus reducing the total costs arouse out of the general process of the education.
- Enabling recording of the previous tour information for future usage.
- Spreading of education to the lower class students by enabling them to participate in the training process and therefore providing a relative widening of education process.
- Decreasing worries of the families about their children through forming an atmosphere that the candidate families can follow the candidates

Besides the advantages listed above, the system has also some disadvantages. One of these is the initial cost for establishment of the infrastructure of the system. Although it does not necessitate very big investments, its requiring for an obvious infrastructure cost is seen as a disadvantage. In addition to this, education of the materials that will be used in the system and a preliminary education process needed for technological products to be able to used in the system can also be seen as a disadvantage. However, despite all these disadvantages, considering the gains that can be obtained, this system can easily take its place in education of tourist guide.

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Modeling with Technology: Mindtools for Conceptual Change

(Book Review)

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Modeling with Technology: Mindtools for Conceptual Change
David H. Jonassen
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David H. Jonassen is a Distinguished Professor of Education, School of Information Science and Learning Technologies at University of Missouri-Columbia. Dr. Jonassen has written extensively on the use of technology to engage critical thinking and problem solving to facilitate learning in his series of books on the use of Mindtools in Education. He is perhaps best known for conceptualizing the idea of "Mindtools" which, briefly described here, refer to the use of learning environments and particular types of software as cognitive tools to engage and support the learner in critical thinking and problem-solving.

Jonassen has given us a series of three books aimed at K-12 classroom teachers that describe how Mindtools aligns with a constructivist view of learning. The first edition, *Computers in the classroom: Mindtools for critical thinking* (1996) introduced readers to the term "Mindtools" to engage students in constructivist activities that support critical thinking and problem solving instead of teaching for memorization. This book was followed with *Computers as Mindtools for Schools: Engaging Critical Thinking*. (2000).

In his third edition *Modeling with Technology: Mindtools for Conceptual Change* (2006) Jonassen promotes the use of Mindtools for facilitating *conceptual change*. He states that his purpose is to convince the reader that "constructing models facilitates intense cognitive and social activities that result in conceptual change." This review attempts to determine if Jonassen is successful in this purpose.

According to Jonassen , models are products of Mindtools that enable the learner to externalize, through visual representation, their mental abstraction of a construct (its components and their interrelationships). He states that "If you cannot build a model of what you think you know, then you do not really know it" (p. xiv). Jonassen uses nine different types of software (databases, spreadsheets, concept maps, expert systems, systems modeling tools, simulations, visualization tools, hypermedia, and electronic conferencing) to demonstrate how learners can model what they know. He proposes that through the process of model building with these tools, learners will externalize their conceptions, reveal their misconceptions, and thus lead to conceptual change.

The book is divided into three parts that address the *why, what,* and *how* models should be used to facilitate conceptual change. Part 1 provides a brief overview designed to educate the reader on model building as agents of conceptual change. Part 2 describes the types of phenomena that can be modeled. Here, readers are shown how to frame and present subject matter according to the different ways it can be modeled, for example as knowledge or a system, or a problem space. This perspective broadens the reader's view of the role of cognitive tools to include construction of models (literal and mental) of the phenomenon they are studying. Part 3 describes how Mindtools can model these phenomena. The description of each Mindtool is useful for readers who are unfamiliar with Jonassen's work. There is a separate section for each type of Mindtools used in model building –for example, an experience (story) may be modeled using hypermedia that represents the relationships between events. Each of these sections includes criteria for assessing models built with the tool. Assessment is an integral part of the teaching process therefore the inclusion of assessment criteria increases the utility of the book for teachers. A brief critique of each modeling tool will help teachers optimize their use and avoid problems. Finally, a step-by-step example of a classroom activity demonstrates how a Mindtool can be used to build a model.

In Chapter 1, Jonassen outlines a brief description of the field of conceptual change which he characterizes as a process in which a learner's prior conceptual knowledge conflicts with the presentation of new, anomalous phenomenon. If the learner's extant mental model cannot accommodate or assimilate new information then one of two things happens: the learner rejects the new information or the learner restructures their mental model to accommodate the new information. In the latter case, the generation of a new personal theory or mental model to explain the anomalous information is known as conceptual change. Jonassen believes this process is fundamental to learning. However, he goes on to create a model of this theory of conceptual change associated with cognitive conflict as a way of demonstrating the value of modeling conceptual understanding using a systems modeling tool called Stella. He then describes and constructs another model of conceptual change (that he calls a revisionist model) that de-emphasizes the need for cognitive conflict as a mechanism for invoking change. Unfortunately, the demonstration leaves the reader with the idea that it might be impossible to convey the concept of conceptual change using such a tool, as there is little support given to making meaningful comparisons between the two models. It was almost as if different people constructed the two different models and we missed the "learning" that was associated with constructing the alternatives. Therefore Chapter 1 concludes with a somewhat confusing and hence unconvincing proposition that constructing models facilitates conceptual change.

In Chapter 2, Jonassen offers some very useful categories for thinking about modeling and learning, that is modeling domain knowledge, modeling systems, modeling problems, modeling experiences (stories) and modeling thinking (cognitive simulations) that he later is able to map onto to particular technologies and tools. However, there was only a tenuous connection between the process of modeling and the process of conceptual change other than his assertion that learning is enhanced by modeling, and therefore conceptual change occurs.

Chapter 3 provides a provocative discussion of the issue of assessing learning. Jonassen falls back on discussions on critical thinking from the previous edition and the need for assessing higher order learning outcomes, suggesting simple rubrics for general processes for knowledge construction, self-regulation, collaboration and critical thinking. Little is provided that helps with the complexity and labour-intensive nature of assessing conceptual change by considering changes in model construction. The strength of the book for teachers is contained in Part Two: Chapters 4-8 where Jonassen provides solid descriptions and examples of the modeling categories he suggested in Chapter 2. The chapter includes an intriguing discussion of modeling experiences where he describes a fascinating student ethnography project called Learning Constellations.

In Part Three Jonassen attempts to map the types of modeling with the actual tools, and in most cases this is a useful and engaging set of chapters. However, there is little connection with these tools and the theory of conceptual change, other than his own stated relationship between constructing models and conceptual change. Elementary teachers are less likely to find the use of complex applications such as expert systems or the more recent agent-based modeling tools.

Jonassen's latest work provides teachers with another context in which to use Mindtools thus extending their use in the classroom. The book is divided into three parts that address the *why, what,* and *how* models should be used to facilitate conceptual change. Part 1 provides a brief overview designed to educate the reader on model building as agents of conceptual change. Part 2 describes the types of phenomena that can be modeled. Here, readers are shown how to frame and present subject matter according to the different ways it can be modeled, for example as

knowledge or a system, or a problem space. This perspective broadens the reader's view of the role of cognitive tools to include construction of models (literal and mental) of the phenomenon they are studying. Part 3 describes how Mindtools can model these phenomena. The description of each Mindtool is useful for readers who are unfamiliar with Jonassen's work. There is a separate section for each type of Mindtools used in model building –for example, an experience (story) may be modeled using hypermedia that represents the relationships between events. Each of these sections includes criteria for assessing models built with the tool. Assessment is an integral part of the teaching process therefore the inclusion of assessment criteria increases the utility of the book for teachers. A brief critique of each modeling tool will help teachers optimize their use and avoid problems. Finally, a step-by-step example of a classroom activity demonstrates how a Mindtool can be used to build a model.

The generous use of visual aids adds explanatory power to a fairly academic text. Most graphics are screenshots of models created by Mindtools such as databases, spreadsheets and concept maps. However, there are many screen shots of models built with the system modeling software STELLA™, a visualization tool for modeling dynamic systems. Unfortunately, the notation and semantics of the notation used by STELLA™ is likely not commonly known to Jonassen's intended audience and therefore undermine the clarity of these models to the reader.

Although Jonassen identifies his readers as classroom teachers, this book, as well as the prior two, is also used as course texts for both undergraduate and graduate courses in education –in particular instructional technology. The academic language and references to the research literature are indicative of its suitability for graduate students and researchers in instructional technology and instructional design. While the academic nature of the book does not preclude its utility to classroom teachers, a solid familiarity with the function of Mindtools in a constructivist environment is recommended in order to follow the ideas presented. Busy classroom teachers generally value books that provide methods accompanied by practical examples. Jonassen attempts to fulfill the needs of both but teachers may find the text too academic.

We conclude that Jonassen is successful in his description of how models may be used as tools for promoting conceptual change. However, the visual and conceptual complexities of the cognitive conflict and revisionist theory models presented in Chapter 1, combined with their ambiguous comparison may leave the novice reader unconvinced about the ability of such tools to effectively represent mental models. We recommend that the author reconsider how these theories of conceptual might be more effectively represented and their differences explained.

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Interactions in online education

(Book Review)

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Online education progresses rapidly with the swift evolution of ICT. Among all these issues related to online education, interaction has been identified as key to successful teaching and learning. How to maintain interactivity draws most attention of educators, instructional designers, developers and researchers because it is proven to prompt knowledge construction and meaningful learning. However, some online educators are facing the challenges of designing, developing and facilitating interactions. "Interactions in online education", which is based on theory and practice, experience-based and reflective teaching techniques, provides guidelines for educators to promote interaction in e-learning environment. This book aims to underscore the magnitude and examine the nature of existing interactions to offer practicable teaching strategies.

This book consists of 13 chapters and covers 4 sections: theoretical and pedagogical perspectives, design and learning environment, practice and professional development. Section 1 proposes frameworks for educators to clarify the structure of interactions and review their functions from pedagogical perspectives. Chapter 1, "Theoretical perspectives on interactivity in e-learning", presents the category of interactivity at 3 levels: interaction with concepts, task and people, which parallel the learning cycle of conceptualization, construction and dialogue. Chapter 2, "Encounter theory: a model to enhance online communication, interaction and engagement", regards interactions as a series of changing encounters and negotiations between stakeholders, like designers, learners, teachers, administrators and technicians. Next, the authors demostrate how to create effective encounters through case study. Chapter 3, "Analysing and designing e-learning interactions", provides 3 levels of planned e-learning interactions, including learner-self, learner-interface, and learner-instruction interactions, to explain how the framework can be used to design, analyse and organize interactions.

Section 2 deals with how to authenticate and contextualize interactions in designing e-learning activities, including the use of games, learning objects and simulations. In Chapter 4, "Designing interaction as a dialogue game", the authors illustrate an example by introducing a social-cognitive tool called InterLoc. Chapter 5, "A model of authentic activities for online learning", highlights the quality of interactivity depends on how authentic the learning task is. Next, the authors provide a model and 10 design principles for developing authentic activities. Chapter 6, "Learning designs, learner interactions and learning objects", develops a model of combining learning designs and reusable learning objects technologies. Chapter 7, "Methods of learning in simulation environments", depicts how to use simulation in e-learning based on problem-solving on a screen, and how interactions and feedbacks in simulations have contributed in enhancing learners' higher order thinking.

Section 3 outlines the previous concepts and addresses how to apply interactions in practice in online learning. Chapter 8, "Interaction in learning and teaching on the Educational Semantic Web", classifies the interactions in ESW and presents a model designed for learner-paced study. Chapter 9, "Interactions in online discussions", discusses synchronous and asynchronous interaction forms. Chapter 10, "Interactions in online peer learning", shows the potential of peer learning mode with the support of pedagogy and technology. Chapter 11, "Interactions in teaching by videoconferencing", analyses how videoconferencing and face-to-face interaction can be blended to enable interactive learning.

Section 4 offers teaching guides for faculty to acquire professional development. Chapter 12, "Professional development of online facilitators in enhancing interactions and engagement", focuses on the importance of reflection in professional learning and practice. Chapter 13, "Developing competencies for online and distance education", analyzes the role of distance educators in changing times and examines the competencies required in distance and online education.

This book explores how to conceptualize and analyse interactivity in theory and how interactions foster learning and reflection in practice. The first section recognises interaction as an essential part to deeper learning by extending a vast network of previous knowledge. The following sections detail that interactions can be shaped by well-designed and well-developed instruction and are beneficial to the co-construction knowledge process. Section 4 concludes guides at the end of the book which clearly illustrate the practice of core concepts. By reviewing learning theory and teaching experience, these authors examine the forms and functions of interactions by providing pedagogical framework and application.

Overall, this book is conceptually comprehensive and offering accessible resource. Not only all the examples in this book mirror the possible potential of existing interactions in e-learning today, but also the case studies detail how interactions can be designed and developed effectively to facilitate online learning while classifying and defining online interactions. However, not all interactions are highly designable as well as meaningful to students. One of my reflections is to take the social and cultural dimensions of interactions into account because in constructivist learning theory, learning is the process of social interaction and co-construction. Moreover, while interpreting online interactions, the engagement of students and the characteristics of media need to be further explored because the media per se covers messages, which include the interrelation hidden among the instructors, designers, and students. Despite these limitations, I would highly recommend this book as a remarkable reference for instructors and researchers and as a handbook for designers and administrators because it gives many useful background knowledge on how interactions work in reality and instructors can easily select topics related to their interest in a variety of contexts.

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