Editorial for EJEL volume 13 Issue 5

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EJEL Editors

E-Learning is dynamic and ever changing and there is an ongoing need for studies that enhance and improve e-Learning technically and pedagogically. This issue contains 8 papers all relating to the overall scope of doing e-Learning. The articles take different approaches to explore various ways of improving e-Learning from various points of perspectives: the personal and self-regulated learning of the students; ways for teachers to get insight into the students learning and institutional approaches to develop online-competent tutors.

Theodoros Karvounidis writes about the development of the framework: i-SERF (integrated-Self Evaluated and Regulated Framework) and a pilot study which utilizes this framework. The paper is primarily a thorough discussion and presentation of the i-SERF thinking framework, which consist of 2 layers. The first is an inner layer that concerns the educational perspectives, including the dynamic relationships and interactions of three primary forms of knowledge: Content, Pedagogy, and Technology. This inner layer also deals with the infrastructure, i.e. the technologies used to support these forms of knowledge. The second and outer layer focuses on evaluation and self-evaluation, hereunder a so-called self-feeding mechanism. As such the paper writes itself into the tradition of personal and self-regulated learning.

Vázquez-Cano, Meneses and Sánchez-Serrano take their point of departure in the challenge that ongoing changes in ICT demands updated methodological practices and content in Higher Education. They argue that all professionals with a university degree, regardless of the subject area, will have to demonstrate adequate competencies to implement plans and strategies using ICT tools in the socio-technological environment. The presented study explore Multimedia Concept Maps (MCM) and Online Discussion Forums as ICT tools to identify areas of intervention. The data material was produced over three academic years and analyzed using qualitative analysis (word frequencies and social network analysis). The authors conclude that design and implementation of MCMs and online discussion forums can contribute significantly to the development of generic and specific strategies in the European Higher Education Area such as: self-regulated learning, communicative, instrumental and interpersonal competencies.

In their paper Hwang, Wong, Lam and Lam provide insights into an empirical study of two different forms of student response systems in class teaching. One is a traditional clicker and the other was using a mobile device. The authors found that students preferred the traditional clickers and discuss how and why the usability of such systems and the student preferences towards a specific system, are both pivotal factors for students learning experience.

Ramachandiran, Jomhari, Thiyagaraja and Maria studies how Virtual Environments including virtual agents may enhance autistic children’s learning, when learning about ‘how to behave’ at specific places or scenarios. They argue that it is necessary to understand the e-learner in order to provide effective learning tools for autistic children, in particular when the focus is not only to develop their knowledge, but also their behaviours. A prototype of a toilet virtual environment with a virtual agent was designed for behavioural learning among autistic children and tested among 41 autistic children and their parents. The study provides insight into the users’ needs and preferences when designing learning environments for autistic children.

Stevenson, Hedberg, Highfield and Diao discuss mobile devices and the available apps on these devices, as used in learning processes. They do this through the provision of a state-of-the-art review. Here, a significant part of the recent literature is walked-through and they highlight relevant case studies, exploring the relationship between the technologies in use, and the media and visual literacies at play. The authors argue that educational institutions should focus less on infrastructure-led developments and look towards more learner-led solutions.

In his study, Almpanis explore the development needs of tutors who teach in blended and online environments in Higher Education Institutions in UK and the ways these institutions address these needs and deal with support regarding Technology Enhanced Learning. Using a mixed methods approach the study...
collects data among heads of e-Learning departments in various Higher Education Institutions in UK. The study found that the institutions perceived potential of technology to enhance the learning led to the adoption of a wide range of approaches to staff development in this particular area. However the study also found that successful implementation of Technology Enhanced Learning requires a coordinated institutional approach and a long-term investment.

The paper by Nitchot and Gilbert is an empirical study addressing the question of whether the Web contains pedagogical materials. The paper provides explanation of the competency models and structures and on the basis of this develops a competence-based system for recommending study materials from the web, and compares the results of using the competence-based system COSREW with the use of traditional search engines. The study concludes that the Web is currently not a good resource for a pedagogically informed competence-based system since Web pages predominantly comprise text-based subject matter content with little support for learning competence or capability.

In the last paper of this issue Al-Azawei and Lundqvist take their outset in current research that indicates that although distance-learning is related to positive core features its efficacy is not consistent across all learners. The study uses Technology Acceptance Model (TAM), one of the most commonly used models to examine factors that can help towards the prediction of user intention to accept technologies, or perceived satisfaction. Here Tam is used and extended to examine perceived satisfaction of an Arabic sample in a purposefully developed online learning course based on the Felder and Silverman Learning Styles Model (FSLSM) in order to reveal the pedagogical implications of learning styles on learner satisfaction. The study found that neither learning styles nor gender diversity had direct influence on the dependent factors. Accordingly, the research suggested that other variables may have to be integrated to enhance the power of the TAM-model.
i-SERF: An Integrated Self-Evaluated and Regulated Framework for Deploying Web 2.0 Technologies in the Educational Process

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Abstract: In this paper we propose i-SERF (integrated-Self Evaluated and Regulated Framework) an integrated self-evaluated and regulated framework, which facilitates synchronous and asynchronous education, focusing on teaching and learning in higher education. The i-SERF framework is a two-layered framework that takes into account various elements of existing frameworks, introducing though as a new element the means of a self-evaluation, self-feeding and regulation mechanism. This mechanism is based on the performance of students, on the students’ answers to appropriately structured questionnaires and on the online monitoring of the supporting platform’s parameters. The outcome derived from a “self-evaluation” process is then feeding i-SERF in order to obtain self-regulation, for the next deployment. In this way, i-SERF remains alive and progressing. The proposed framework aims to offer the needed background for designing Web 2.0 educational platforms that may exhibit continuous improvement functions, providing in that way considerable benefits to both students and tutors in various fields. A pilot implementation, using an education-oriented suite with enriched interactive elements supporting a variety of terminal devices, combined with a thorough assessment that utilizes advanced statistical tools has revealed the potentials of the platform to successfully deploy the principles of the i-SERF framework to yield powerful learning experiences and high quality interactions between students and teachers.

Keywords: Education, Learning, Framework, Self-evaluation mechanism, Web 2.0

1. Introduction

Web 2.0 technologies encompass a variety of different meanings, including an increased emphasis on user generated content, data and content sharing, collaborative efforts, new ways of interacting with Web-based applications, and the use of the Web as a social platform for generating, repositioning and consuming content (Harris & Rea, 2009). These technologies have been deployed widely since 2004 (O’Reilly, 2005) as part of the social networking revolution. The field of education could not remain unaffected as today’s learners demand from the educational institutions to continuously assess their pedagogical approaches to the learning and teaching process, both in face-to-face and in virtual classrooms (Huertas et al., 2007).

In the scientific literature, one can find several works which argue that technologies can never be neutral; they have specific affordances that might facilitate certain approaches and minimise others (Dron 2006; Feldstein & Masson 2006). The technology itself is neither good nor bad; it is the way that it is exploited that matters (Bates 2005; Nichols 2005). According to Bates (2005), a useful approach is to identify the kinds of learning that different media facilitate best, and under what conditions. The issue, then, is whether we are using technology to do the same things, or we take advantage of the unique capabilities of the technology to do things differently (Oblinger & Hawkins 2006). The successful incorporation of a new technological element or infrastructure in education pre-supposes its effective integration with pedagogical knowledge and context (subject matter) specialties. Education though is a dynamic and open system with “material” transfers into or out of the system boundary, which remains progressive as long as it catches and re-acts at all macroscopic and microscopic stimuli. Therefore, this process mandates the setting up of an evaluation and regulation mechanism which will continuously and appropriately feed the educational framework, aiming to improve the teaching and learning processes.

Even though the incorporation of Web 2.0 tools in education has been the focus of numerous studies in the literature, either focusing on individual components of social networking in educational settings, such as blogs and Wikis (Divitini et al., 2005), or operationally partnered with pedagogy and context in a Web 2.0 learning

ISSN 1479-4403  
framework (Bower et al., 2009; Wan, 2010; Glud et al. 2010), this evaluation and regulation mechanism is still non existing.

In this work, an integrated self-evaluated and regulated framework, the i-SERF (integrated-Self Evaluated and Regulated Framework), is proposed which covers synchronous and asynchronous education, focusing on teaching and learning in higher education. The i-SERF framework is a two-layered framework that takes into account various elements of existing frameworks, introducing though as a new element the means of a self-evaluation, self-feeding and regulation mechanism. This mechanism is based on the performance of students, on the students’ answers to appropriately structured questionnaires and on the online monitoring of the supporting platform’s parameters. The proposed framework aims to offer the needed background for designing Web 2.0 educational platforms that may exhibit continuous improvement functions, providing in that way considerable benefits to both students and tutors in various fields.

The description of this work begins with an overview of the existing practices for Web 2.0 development in higher education. This includes an outline of existing frameworks via which web 2.0 may be deployed and a review of evaluation techniques of learning environments. A thorough description of the i-SERF framework on a “layer basis” and the way it may be deployed is provided next. An outline of the pilot implementation follows, including a brief presentation of the experiment, an outline of the utilized technological infrastructure as well as some initial indicative results. The work finishes with conclusions and future steps.

2. Background Information

There are many types of Web 2.0 tools while new offerings appear very frequently. The challenge is to use these tools as well as other online teaching technologies to enhance learning and teaching, not just because they are available. Their effectiveness, though, cannot not be extensively revealed, if they are not deployed in a structured and systematic manner. As Harris & Rea (2010), point out what Web 2.0 technologies should be deployed in a way that enhances learning and teaching without hindering pedagogy. Regarding the necessity of this approach, Cole (2009) provides some important reflections. In particular, she argues that educational technology must support student needs by creating a balance between the needs of both lecturers and students. She also poses that technology needs to support a pre-existing educational behaviour rather than try to import behaviour from other domains. She also points out that educational institutions must be clear about the intended outcomes of the technology used, and technological interactivity should not be confused with interactive learning. In other words, Cole claims that the on-line learning platform that may host an educational activity must be able to efficiently and effectively manage the individual routines of the educational process and their interactions.

Glud et al. (2009) suggest a learning framework which concentrates on the learning control between teacher and learner. They identify three factors, namely infrastructure, learning process and resources/content plus the factor of motivation, referring to whose initiative a specific course is driven by: the learners’ or the institutions. Mirsha and Koehler (2006) propose the TPACK (Technological Pedagogical Content Knowledge) model, which attempts to capture some of the essential qualities of the teacher knowledge required for technology integration in teaching, while it addresses the complex, multifaceted, and situated nature of this knowledge. TPACK emphasizes on the importance and the dynamic relationship of the three primary forms of knowledge: content, pedagogy, and technology. Wan (2010), based on the analysis of three different models, proposed an integrated framework of using Web 2.0 technologies in e-learning 2.0. The framework consists of Web 2.0 tools, e-learning 2.0 applications and e-learning 2.0 learning modes (informal and social). Bower et al. (2009), propose an approach to conceptualising Web 2.0 enabled learning design based on the TPACK model of educational practice. Their proposal includes a framework of typical use cases to illustrate the range of learning designs that may be applied for different purposes in order to promote a more expedient application of Web 2.0 technologies in teaching and learning.

3. The proposed framework

The i-SERF framework that has been utilized to study the incorporation of Web 2.0 tools in higher education is shown in figure 1.
It consists of two layers: The inner layer (layer-1) is the educational framework that encompasses the dynamic relationships and interactions of three primary forms of knowledge: Content, Pedagogy, and Technology. The composition of layer-1 takes into account concepts and elements of the frameworks described in section 2. The outer level (layer-2) refers to a newly-introduced evaluation and self-feeding mechanism of the “layer-1” structure, which is positioned as its macro-environment. The “layer-2” pre-supposes the live capturing of appropriately selected parameters from “layer-1” during the educational process. These parameters, which are connected to both technological and pedagogical factors, are automatically recorded and evaluated at specific time points of the educational process as well as upon the completion of a course. The outcome of the analysis of these parameters can be the derivation of new factors connected to various aspects of the educational process, the prioritization of the existing factors, or the likely elimination of factors that no longer affect the educational process as a consequence of the system’s evolution. In this way, the framework as a whole is being continuously “self-regulated”, while it is used in the educational process. The analytical description of the two layers is given next.

**Figure 1:** The i-SERF framework

### 3.1 Layer-1

Layer-1” (inner layer) contains four different components: the technological, the pedagogical, the content and the cognitive one, the dynamic relationship and interaction of which take into account the principles of all the previously mentioned literature as well as of the aforementioned frameworks.

#### 3.1.1 Technological perspective of i-SERF

Web 2.0 applications and services allow the publishing and storing of textual information of audio recordings (podcasts), of video material (vidcasts) and of pictures individually by users (blogs) as well as collectively (wikis). The challenge for the educational institutions is then to identify what is valuable in using these tools and to minimise what is not. According to Boulos (2006), although blog, wiki and podcast technologies in higher education have an immense impact, the combined use of them as 'mind tools' (Jonassen, 1999) may result in even stronger learning experiences. According to Jonassen et al (1999), 'mindtools' act as cognitive
reflection and amplification tools, aiding the construction of meaning, through the act of the self-design of knowledge databases. A generic co-relationship, a dependent positioning, and the potential for confluence of the three aforementioned Web 2.0 tools (wikis, blogs and podcasts), within a student centred learning environment has also been shown on Boulou et al., (2006).

The first component of the i-SERF framework, which refers to the technological infrastructure, requires a Virtual Learning Environment (VLE) that allows the creation and formulation of a Personal Learning Environment (PLE) for the needs of synchronous and asynchronous learning. This component is based on the principles of social networking (Europe’s Information Society, 2009). Therefore, it should include all the aforementioned Web 2.0 tools in order to facilitate both the “horizontal” (among peers) and the “vertical” (educators with students and vice versa) communication and to support both static and social course content.

A Blog in i-SERF should be dedicated to a particular course, in order to facilitate the creation of an educator’s “e-office”, providing announcements, annotated links for readings or references, posting of course material and time schedules, networking and personal knowledge sharing. With blogging educators can keep the students engaged by promoting their active participation (Ajjan & Hartshorne, 2008). Educators can also have an indicator of the students’ motivation, misconceptions, struggles, discomforts and learning experiences and they may proceed to necessary accommodations in the instructional activities (Yang, 2009). In this way, they can increase the students’ learning efficiency and satisfaction. Teachers are, thus, provided with the choice to transfer the “control of the learning experience” over to the students’ side and to re-adjust motivation, an issue that has been raised by Glud’s et al framework. Of course, the final decision about the balancing control with the educational environment depends mainly on the pedagogical view of the activity as well as on the nature of the subject matter that is being processed.

Wikis have their place in i-SERF as they provide an editable website that is created incrementally by visitors. Wikis can be used to facilitate computer-supported collaborative learning (Augar et al., 2004), to enhance peer interaction and group work, and to facilitate the sharing and distribution of knowledge and expertise among a community of learners (Lipponen, 2002). Wikis enhance asynchronous communication and cooperative learning among students and promote cooperation rather than competition (De Pedro et al., 2006). Using a wiki as a writing tool maximizes the advantages of reflection, reviewing, publication, and of observing cumulative written results as they unfold (Fountain, 2005). Duffy and Burns (2004) list several possible educational uses of wikis, with group authoring being the most common pedagogical application. Cole (2009), at a failed action research experiment to integrate a wiki into an existing teaching format, reveals that the reasons of failure ranged from academic pressure from other courses (educational constraint) to ease of use concerns (technical constraint) to issues of self-confidence (personal constraint) and, finally, to a total lack of interest. Hence, with a savvy learning design, the benefits of social interaction and active participation experienced by collaborating online may not be diminished by any of the encountered drawbacks.

Podcasting technology, allows the easy broadcasting of audio and audio-visual files. It is expected that podcasting within i-SERF will enable the dissemination of learner-generated content to participants, which, in turn, will act as a catalyst and support for learning. The most popular use of podcasts in education is the provision of introductory or preparatory material before lectures, or, more commonly, the recording of lectures and their reproduction in order to be accessed by students because they were unable to attend the lectures physically, or to reinforce their learning. Therefore, the quality of the audio-visual files that contain the live classroom material, in terms of content and presentation, determines the extent to which a podcast affects a lecture’s reproduction by reproducing it. Similarly, the “easiness” of access to a repository of podcasts also influences the students’ engagement to actively participate in a course, since podcasts require high speed Internet access for streaming or downloading. Fernandez et al.’s (2009) research work revealed that podcasting is a powerful tool as a complement to traditional course resources, but not regardless of them.

Microblogging is one of the latest Web 2.0 technologies. The key elements of microblogging are online communication using 140 characters and the fact that it involves “following” someone. Microblogs cover the gap between blog and direct messaging. Popular microblogging platforms used in education include Twitter, Cirip, Edmodo and Plurk. As the technology of microblogging is adopted in a variety of contexts, its usefulness becomes increasingly compelling for educational actors. A list of basic functions that microblogging can provide are: outasking questions, giving opinions, changing ideas, sharing resources and reflection (Ebner et al., 2010).
Social bookmarking is the practice of saving bookmarks to a public Web site and “tagging” them with keywords. In education teachers and students can create lists of ‘bookmarks’ or ‘favourites’ (for instance reading lists or collections of resources) and they can store them centrally on a remote service, so that they are able to share them in a local or a wider educational community.

In all cases, RSS (Really Simple Syndication) feeds benefit educators by letting them syndicate content automatically.

Finally, the technological infrastructure should be capable of facilitating online lectures and supporting a live class. During the online lectures, the educators should have at their disposal a variety of synchronous technologies, including a slide presentation view with cursor, raise hand, public and private chat, audio and video conferencing, desktop sharing and shared whiteboard.

3.1.2 Pedagogical perspective

The second component deals with the pedagogical perspective of the framework. This component includes potential pedagogies, learning approaches and best practices in teaching and learning the deployment of which may enhance teaching and learning. Within the life cycle of a course, the nature of the activities may vary (for instance they may include theory or laboratory), which in turn influences the nature of the pedagogy to be applied from the teachers’ point of view and the learning practices from the students point of view. Since i-SERF deals with online activities supported by the Web 2.0 technological infrastructure, the aim of this part of the framework is to define pedagogies and learning practices, which in their interaction with technology and context may yield better teaching and learning experiences.

There are various pedagogical theories and models that underpin the theoretical background of the use of Web 2.0 in education, some of which have been investigated even before the predominance of ICT. The most recent theories, the use of which may enhance the teaching and learning process on a Web 2.0 platform, are the theory of learning communities, the theory of Bandura (Social Learning Theory), the communities of practice and the virtual communities (Wenger & Snyder, 2000; Andreatos, 2008). In 2005, Siemens formulated a relatively new theory, called Connectivism (Siemens, 2005). Connectivism is a relatively new learning theory combining relevant elements of many learning theories, social structures and technology to create a powerful theoretical construct for learning in the digital age, including the fact that the acquired knowledge is constantly decreasing. The latter makes informal learning through personal social networks, communities of practice and the like very important in the workplace (Andreatos, 2007).

Constructionism, advocated by Seymour Papert, is particularly amenable to Web 2.0 approaches. Constructionist learning is inspired by the constructivist theory that individual learners construct mental models to understand the world around them. However, constructionism argues that learning can happen most effectively when students are also active in making tangible objects in the real world. Clements (2009), as cited by Bower (2009), describes virtual constructionism as “understanding the relationship between teaching and student learning, and integrating it effectively with e-learning technologies to support students in constructing meaningful experiences”. Therefore, prior to practicing constructionist approaches in a Web 2.0 environment an understanding of the Web 2.0 tools that best apply to the accomplishment of a particular task is presupposed.

Behaviourism in a Web 2.0 environment has an important role, since the environment itself provides stimuli that cause the occurrence of behavioural consequences, observed over a Web 2.0 platform, not only for the user himself but also for the rest of the participants in the “mini” internet-community of a university course. These consequences may have an effect on the learning process. Thus, teachers attending to the changes in the behaviour of users are in the position to directly diagnose their learning needs, encourage them, support them and guide them online. i-SERF introduces a self-evaluation mechanism (the detailed description of which is included in the “layer-2” description) which is based on the performance of students, on the students’ answers to appropriately structured questionnaires and on the on-line monitoring of the supporting platform’s parameters. Therefore, the pedagogical implications of the behavioral learning processes are considered mandatory in the layer-1 learning process component.
Finally, a transmissive learning process, is included in the learning component of layer-1, whereas a stream of information is broadcast to students (Bower, 2009), either within the “online” class (synchronous) or via podcast technology (asynchronous).

Beyond the purely pedagogical approach, the optimal adoption of Web 2.0 should take into account existing best practices to achieve the full-scale deployment of any proposed framework and to minimize the possibility of misleading conclusions. The literature is rich with “best practices” aiming to improve the students’ learning processes in higher education. Within the scope of i-SERF, these practices may act complementarily to the aforementioned “established” learning theories while providing practical tips at instances that are not sufficiently covered by these theories. One widely accepted practice is the one of Angelo (1993), who suggests that students learn best when they receive feedback quickly and at regular intervals, that information that is organized in a personal way is more likely to be understood, preserved and recalled whenever necessary and that the assessment and evaluation method of the students’ performance strongly affects their study and learning process.

3.1.3 Knowledge and Cognitive Process Dimension

The third and fourth components correspond respectively to the knowledge dimension and the cognitive process dimension of the Anderson and Krathwohl Taxonomy of Learning, Teaching and Assessing (Anderson & Krathwohl, 2001), as elaborated by Bower et al. (2009) in their framework.

Following one of the biggest key ideas of Tim O’Reilly, that of the “Individual Production and User Generated Content” (Anderson, 2007), Web 2.0 tools have lowered the entry barriers concerning the creation of information. Towards this goal, individuals are setting up their personal blogs, they post to blogs other than theirs, they participate in forums and they work collaboratively to create information via wikis. Content can be created from scratch or existing content may be edited and altered in several ways. Content can be used purely as data, as part of a process, or as an enabler of social software and social interaction (Franklin & Van Harmelen, 2007). From an educational point of view, the content is the specific knowledge that the learning design should address. Anderson and Krathwohl incorporate a knowledge dimension and a cognitive process dimension in a learning framework. Then they distinguish knowledge according to the kind of the orientation of matter content as: Factual, Conceptual, Procedural and Metacognitive. The level of this cognitive process dimension includes: Remembering, Understanding, Applying, Analysing, Evaluating and Creating. These levels represent a continuum from lower order thinking skills to higher order thinking skills, with lower level thinking capacities being a necessary prerequisite for the corresponding higher order thinking skills to occur (Bower, 2009).

3.2 Layer-2

“Layer 2” (outer layer), incorporates the evaluation and the analysis of the “layer-1” structure.

3.2.1 Description of the Evaluation Strategy

As a base for establishing the evaluation procedure, the statistical process control (SPC) toolbox is used. This set of techniques has been extensively used for monitoring and controlling industrial processes. The monitoring and controlling of the process ensures that it operates at its full potential. At its full potential, the process can make as much as possible “conforming products” (output meeting specifications) with a minimum of “non-conforming products”. Today, the use of SPC techniques has been also extended in non-industrial processes, since SPC can be applied to any process where output can be measured. Control charts are the key tools used in SPC, as they assist in the early detection and prevention of problems, rather than in the correction of problems after they have occurred. The evaluation strategy is described in the following paragraphs.

A. Evaluation System Characteristics

“Layer-2” presupposes the live capturing of appropriately selected parameters connected to both technological and pedagogical factors. These parameters are automatically recorded and evaluated at specific time points of the educational process as well as upon the completion of a course. The recorded parameters used for evaluation are divided into the following sub-sets:
Sub-set 1 includes parameters of the Web 2.0 platform related to the frequency, the duration and the type of its use by the students.

Sub-set 2 includes parameters related to the performance of the students. The acquisition of this data is done using appropriate online tests (e-tests), connected to the course material at specific time-points.

Sub-set 3 includes parameters related to the satisfaction of the students. The acquisition of this data is achieved using appropriate electronic questionnaires

Thus, the frequent capturing of data in various forms allows tutors to assess the students’ “behaviour”, “performance” and “satisfaction” within the course lifetime and to consider the possibility of proceeding in correcting actions, not only at the end of the course based on cumulative results but also in between, whenever that is considered necessary.

Of course, it is not always possible for the tutor to manage this vast amount of data. Thus, in order to achieve the self-evaluation of the system, the recorded parameters are appropriately analysed using advanced statistical analysis techniques and state-of-the-art statistical process control (SPC) techniques (Balakrishnan et al., 2009). SPC techniques have been embedded in the field of education after being properly adjusted, in order to monitor and control the individual performance of students, the satisfaction of the students from the platform and the use of the system by the students.

The specific SPC toolbox that is used for achieving the total monitoring of the educational procedure is the multivariate SPC toolbox (Bersimis et al. 2007; Koutras et al., 2006), and, in particular, the methodologies based on dimension reduction techniques. Multivariate SPC takes into account, apart from the marginal variability of each characteristic, the complex structure formed by the interactions between the monitored parameters.

The use of the SPC toolbox was born by the fact that every student has its own nominal level regarding a subject, a level that is related to this specific subject as well as to the result of a long-term educational process. Moreover, the need of MSPC (Multivariate SPC) techniques is born by the fact that the class performance affects the individuals’ performance while the individuals’ performance affects class performance. Thus, using MSPC we may monitor simultaneously class as well as individuals’ performance.

B. Phases of the Evaluation

As in standard SPC practice, two distinct phases are used: Phase I and Phase II. In Phase I, the basic aim is to test historical data for identifying whether they were sampled from an in-control process and to define the in-control state. In Phase II, the basic aim is to test future data for specifying whether the process remains in-control or has shifted to the out-of-control state. Specifically, every new observation or subgroup is tested and using specific rules it is decided whether the state of the process has changed or not.

C. Phase I: Initialization of the Evaluation System

An initiation (Phase I) is required in order for the system to reach a nominal level (to define the in-control state). This initiation may be achieved via a pilot implementation, in order to define an “in-control state”. The pilot phase takes the place of Phase I analysis used in the SPC literature. The period of the pilot phase may be defined either as the first weeks of a specific class or as the usual results of the class in the previous years. In practice, all the parameters that are recorded during the pilot implementation are appropriately analysed and the “in-control state” is estimated. The initialization of the evaluation system is done at both the student and the class levels.

Specifically, in the initialization phase the tutor gives to the students the regular tasks. The platform records the necessary data (frequency, duration and type of platform use, performance through short tests and satisfaction through questionnaires). Finally, the mean level for each student for all the parameters as well as the structure of the relations among the parameters are estimated. The mean level is represented by the mean vector

\[ \overline{X} = [\overline{X}_1, \overline{X}_2, \ldots, \overline{X}_{p_{all}}] \]

and the structure of the relations among the parameters is represented by the variance-covariance vector.
Each of the variables $X_1, X_2, ..., X_p$ represents one of the parameters recorded and analysed online. The quantities $S_{11}, S_{12}, ..., S_{pp}$ represent the covariance among two variables, that is the effect of one variable on the other (e.g. the effect of the frequency of the use of the platform on the performance of the individual student).

D. Phase II: Use of the Evaluation System during the Educational Process Evolution

In each future time point, the values of the captured parameters for each student are continuously modelled and compared to the nominal levels estimated during Phase I. Moreover, the platform’s data as well as the questionnaires’ data are combined with the data provided by the e-tests realizing a system that may capture the relation between the effort and the performance of the student. Then, appropriate control charts are used in order to identify possible unusual conditions as well as to interpret them (Maravelakis et al., 2002), in terms of finding the root of these unusual conditions. The identification of a problem and its interpretation are possible because each set of parameters reflects a different aspect of the learning attitude of an individual. Thus, if a control chart related to one student signals, then we may identify a student having a problem. Finally, if the number of students that present an abnormal behaviour is high, evidently the system needs to be improved (class performs abnormal). Thus, the framework as a whole is being continuously “self-regulated”. Another improvement to the abovementioned procedure, could be the use of one sided control charts, since we are interested only in cases that either a student or the class getting worst.

E. Dashboard of the Evaluation System

A $(n \times p)$ dashboard is used for the dynamic handling of all the aforementioned parameters (Figure 2). In the horizontal dimension ($n$-dimension) of the dashboard the names of the students are found, while in the vertical dimension ($p$-dimension) the corresponding parameters.

![Figure 2: Students Control Panel over Dashboard](image-url)
3.2.2 Parameters of the System

As already mentioned the parameters used for evaluation are of three broad categories. The first category includes the extended set of parameters of the Web 2.0 platform used. The system monitors on a daily basis the following parameters: number of visits, time spent in the platform, average time during these visits, cumulative time over the platform, maximum time at one visit over the platform, time spent using each component (podcasts, forums, etc.) of the platform, etc. In this category we include parameters related to the class itself (for example the number of absences in a particular course). Then the data are aggregated on a weekly basis in order to be aligned with the lectures’ schedule. All these parameters are represented as a \(p_1\)-dimensional random vector \(U_{t,i} = 1, 2, \ldots, s\), where \(s\) is the number of students in a class and \(t\) represents time (we may assume that the first time points can be used in order to estimate the nominal level of each student).

The second category includes the periodic capturing of the performance of the students using appropriate fast e-tests (on a weekly basis) and tasks. Each week, an e-test is used in order to evaluate the effort that is put by each student. Additionally, the performance is evaluated by taking into account the grades per assignment. The performance of each student is represented as a \(p_2\)-dimensional random vector \(Y_{t,i} = 1, 2, \ldots, s, t = 1, 2, \ldots\).

The third category includes the periodic capturing of the satisfaction of the students using the pre-programmed sampling of the electronic questionnaires. The students, on a monthly basis (the results are then conversed to a weekly basis), answer a structured questionnaire related to the satisfaction of the students from the platform as well as from the class itself.

Here we have to note that in order to reclaim the questionnaire data in the initialization phase an extended use of the multivariate analysis technique Factor Analysis is performed.

Specifically, in Phase I a historical data set is analysed and the most significant factors are accrued. Each factor is strongly related to a different aspect of the learning attitude of an individual. Since each factor is independent from the others, we may monitor and control more than one parameter in a single control chart for each individual, while additionally we may control the overall learning procedure. The satisfaction of each student is represented as a \(p_3\)-dimensional random vector \(F_{t,i} = 1, 2, \ldots, s, t = 1, 2, \ldots\).

By joining the random vectors \(U, Y, F\), we create the random vector \(X_i\) having \(p\) dimensions that represents all the parameters. In Phase I we estimate the mean of \(X\), say \(\mu\), which acts as the nominal level of each student.

3.2.3 Monitoring

In Phase II, monitoring is performed using the Shewhart-type chi-square multivariate control chart (CSCC), in which, for each time point \(t\), a statistic of the form is calculated,

\[
(X_t - \overline{X})^T S^{-1} (X_t - \overline{X}), \quad t = 1, 2, \ldots, \tag{1}
\]

where \(\overline{X}\) is the sample mean vector, \(S\) is the sample covariance matrix and \(X_t\) is the respective multivariate observation at time \(t\) for a certain student. Then, this statistic is plotted in a control chart with suitable control limits calculated from an appropriate \(F\) distribution. In case that for a certain time \(t\) we do not have the complete information we replace the missing value with the historical mean.

In figure 3 we present the control chart for a sample class for the duration of a year. In the \(x\)-axis we represent the time (e.g. the lecture number) while in the \(y\)-axis the values from equation (1). As we can see at the last time points we have large values of \((X_t - \overline{X})^T S^{-1} (X_t - \overline{X})\), \(t = 1, 2, \ldots\) which means that there exist large differences from the nominal. The next step is to diagnose if these differences are due to improvement or due to deterioration. As already mentioned we could use an appropriate one sided control chart, since we are interested only in cases that either a student or the class getting worst. However, this is an open problem in the MSPC field.
In order to assess the effectiveness of i-SERF, a pilot implementation has been carried out within a course lifetime in the Department of Informatics of a Greek university. At this aspect the pilot implementation aimed to investigate the lead factors, derived from selected parameters connected to the students’ behaviour, perceptions and satisfaction that may be taken into consideration in the incorporation of a Web 2.0 learning environment in the educational process driven by the i-SERF framework. Moreover, the investigation included the study of the correlations of these factors and their effect on the students’ performance. Finally, we studied how the students’ activities on the online environment affected their performance. The full description of the pilot implementation has been presented in (Karvounidis et. al, 2014) and in (Karvounidis et. al, 2015), respectively.

The target group was IT students, who were considered to be academically more competent to new technologies compared to other target groups, and, hence, having higher expectations, since they do not judge only as users, but also as potential creators or enhancers of these technologies. The implementation plan included the splitting of the “audience” into two groups. Lectures were given once for both groups: The first group (Group A) was attending lectures in the classroom and used all the available at the university conventional and commonly-used infrastructures for communicating and providing information and material for the successful completion of the course. The second group (Group B) was attending lectures “web-based” via the electronic medium at the same time from a terminal device of their choice and using exclusively Web 2.0 tools to successfully fulfill the course requirements. The basic rule was that the two groups do not meet and work with each other within the framework of the particular course. All the participation rules were clearly stated during a presentation at the very beginning of the course. In order to reduce the possibility of “contamination” of the outcome of the experiment, the participation in the experiment was voluntary and the students consented that “rules” will not be violated.

For the evaluation of the results of the experiment, descriptive and inferential statistics methods (Johnson et al., 2007) in combination with the multivariate analysis technique “factor analysis” (Bartholomew et al., 2008) were used. The extraction method used was FA (using Principal Components Analysis method). The design of the questionnaires took into account findings and key points from the literature discussed in the background information. The questionnaires have also been based on existing best practices in accessing information and communication technologies in a university learning environment (such as Breen’s et al. (2001)). The Cronbach’s alpha coefficient of reliability was used in order to measure the internal consistency of each used questionnaire.

The pilot implementation revealed that although the deployment of the i-SERF framework did not directly affect the students’ performance, it is a tool acceptable by both students and faculty. The assessment on students’ perceptions on various aspects related to course deployment indicated viable satisfaction on the deployed process and, consequently, of the particular framework that the course was performed. Empirically,
instructors have expressed their conformity on deploying the i-SERF on the course within a Web 2.0 environment.

The study has also emerged significant correlations and interdependencies between the students’ activities over the used electronic medium (platform) and their performance in various time-points within the course time line. More specifically, the performance has been found to be directly affected by the frequency of the interactions with the electronic medium (platform) at which the educational process has been carried out and indirectly by a variety of factors that aim to enhance their learning interest and experience. In conclusion, the outcome from the pilot implementation showed the Web 2.0 infrastructure is a tool that facilitates on-line learning service delivery, driven of course by a proper framework that leverages the social interaction and active participation within the educational process.

As major limitation of the pilot implementation is considered the fact that the selected group was competent on IT – as expected from students of an Informatics Department. This may resulted on the one hand in valuable remarks regarding technical aspects, on the other hand though, it narrowed the view of the extent of comfortless of a less IT-literate student. Ullrich et al. (2010) when applying Web 2.0 tools in language learning subject - with less IT-literate students than ours – observed that students were not “ready” to use them. In order to have a more complete view of the effectiveness of i-SERF in a Web 2.0 based learning environment, the overall is currently being held with a different student body over a Statistics Department course.

5. Conclusions

In this work, an integrated framework that covers synchronous and asynchronous education in a Web 2.0 learning environment has been proposed. Existing works, principles, views and strategies have been taken into consideration in the development of this framework. The proposed framework embeds self-evaluation and regulation mechanisms that are based on the performance of students as well as on answers to appropriately structured questionnaires and on on-line monitoring of the supporting platform’s parameters.

This research can also be used as the baseline for improving the higher educational process at various levels. It is very important to fully explore the deployment of the proposed framework, and to minimize the possibility of misleading conclusions. Using advanced technologies for online testing in a Web 2.0 environment and by combining knowledge and cognitive dimensions, the proposed framework could also provide, among other benefits, important information (metrics) for the adjustment of the examination tools used in the educational process. Finally the mechanism itself can also been improved in future a research with the implementation a self-adaptive process monitoring system.

Acknowledgement

S. Ber Simis is supported by the Greek General Secretariat for Research and Technology research funding action "ARisteIA II".

References


Analysis of Social Worker and Educator's Areas of Intervention Through Multimedia Concept Maps And Online Discussion Forums In Higher Education

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Abstract: This diachronic study describes an innovative university experience consisting of the development of multimedia concept maps (MCM) in relation to social educators and social workers main intervention areas and an active discussion in online forums about the results obtained. These MCMs were prepared by students who attended the Information Technologies and Communication course as part of the Degree in Social Education and dual Degree in Social Education and Work during the academic years 2010-13 at Pablo Olavide University (Seville-Spain). Following a methodological framework based on virtual, collaborative action-research, a qualitative analysis is implemented to analyze 213 MCMs created by students and their interventions in ad hoc online discussion forums with a twofold methodological approach: firstly a qualitative analysis of word frequencies in MCM through the use of Atlas-Ti software and secondly a forum discussion categorization through a reticular, category based social network analysis using UCINET and yED Graph Editor. Among the most relevant conclusions, we can highlight that a combination of MCMs and discussion forums are highly interactive and collaborative digital resources and are especially beneficial when applied to social studies. Students were able to identify and categorize key areas of social and educational intervention, including: seniors, children, teens and drug dependence, people with disabilities, adults, mental health, socio-community care, and immigrants.

Keywords: social educator, social worker, multimedia concept maps, forums, online discussion, Higher Education

1. Introduction

Access to quality education is a fundamental right which has to face a paradigmatic change at the beginning of the XXI century. Recent Information and Communication Technologies' (ICTs) development needs new updated methodological practices and content according to the new information society (UNESCO, 2013). Thus, these practices contextualized in Higher Education are really important because all professionals with a university degree, regardless of the subject area, will have to demonstrate adequate competencies to implement plans and strategies using ICT tools in the socio-technological environment in which we live (Vázquez-Cano, López-Meneses and Fernández Márquez 2013). In the European Higher Education Area a methodological and assessment change is mandatory in order to enhance overall students' training by developing their technological, intellectual and social skills (Aguaded, López-Meneses and Jaen 2013). In this sense, the design and implementation of multimedia digital objects as well as online discussion forums can and should play an important role in methodological innovation and meta-cognitive strategies and processes, especially when applied to the understanding and conceptualization of social studies. Besides, when the design and development of these multimedia concept maps (MCMs) is embedded in active online learning communities, the collaborative learning is enhanced (LaPointe and Reisetter 2008). Because assessment is the fundamental driver of student learning (Boud and Falchikov 2007), the design of online assessment activities that drive desired learning outcomes is essential.

2. Multimedia concept maps and online discussion forums to foster educational innovation

A concept map is a technique used to develop the ability of creative thinking and increase competition in order to construct knowledge in an organized and inclusive way (Muñoz, 2010). In this sense, Novak and Cañas (2008) show the three main elements of a conceptual map: concept, proposition and line linking. Concept is
defined as a perceived regularity in events or objects, or records of events or objects, designated by a label. The label for most concepts is a word, although sometimes we use symbols such as + or %, and sometimes more than one word is used. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts that are connected using linking words or phrases to form a meaningful statement. Sometimes these are called semantic units, or units of meaning. Figure 1 shows an example of a concept map that describes the structure of concept maps and illustrates the characteristics above (Novak and Cañas 2008).

Figure 1: Conceptual map's structure (Novak y Cañas, 2008)
Source: http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/Fig1CmapAboutCmaps-large.png

Regarding the educational field, besides enhancing student-centered pedagogy (Kinchin 2000), for Estrada and Febles (2000) concept maps are also useful at various stages of the learning process: in the planning phase, as a resource for organizing and viewing the work plan, showing the relations between contents, and schematically summarizing the program of a course. In the development phase, as a tool to help students to interpret the meaning of learning materials and in the assessment phase, as a resource for training and monitoring that makes it possible to view students’ thinking, and if necessary, correct any errors concerning the main concepts.

Thus, research on the instructional effectiveness of concept maps' has already some history in the educational field (Horton et al. 1993). In this sense, different research studies show how concept maps can help to improve students' performance in various knowledge areas (Flateby 2010; Facione 2011), as well as to enhance critical thinking for problem solving, decision making and organization of thoughts (Karabacak 2012). In addition, concept maps reinforce the development of different cognitive operations such as perception, textual memory, reasoning and the ability to synthesize (Tzeng 2009) and demonstrate their effectiveness as tools to improve the assessment of their studies (Ruiz-Primo and Shavelson 1996; Keppensa and Hayb 2008, Cabero, López Meneses and Ballesteros 2009; Lucian, Schalk and Schrujer 2010).

Along with the design and implementation of MCMs, the use of an online discussion forum can encourage deeper analysis, critical thinking and reflection than a student is likely to achieve working alone or in a face to face situation with other students. Herron and Wright (2006) suggest that online discussions can be used to enable socially-mediated reflection. This interpersonal dialogue might be socially orientated or subject-matter orientated, or a mixture of both. (Gorsky and Caspi 2005). The social construction element emphasises the additional value to be gained through collaborative learning, and the programme team want to facilitate and encourage the opportunities for joint learning and construction of knowledge. Students benefit from participating in discussions initiated by other students, they can seek clarification from other students, and build a sense of a scholarly community (Brown 1997; Laurillard 2002). One of the main benefits of asynchronous online discussion for students is having more time to carefully consider their own and other
student’s responses, and to be able to "rewind" a conversation, to pick out threads and make very direct links between different messages (Salmon 2002, 35). Studies have suggested that online community discussion has been well received by students and can result in discussions that are “engaging, vibrant and active” (Revell and Terrell 2005, 240). In particular asynchronous discussion forums are nowadays widely used in formal and informal educational contexts, applying principles of constructivism, emphasizing social interaction during learning activities (Gunawardena et al 1997; Corich et al 2004). These approaches can enhance students’ critical thinking through problem solving and collaboration. It focuses more on the process of learning than just attaining information, involving discovering how to analyze, synthesize, judge and create-apply new knowledge to real-world situations (Walker, 2005). As pointed out by Dillenbourg (1999) it is necessary for the learner to externalize his/her thoughts and ideas in order to achieve proper reflection, thus promoting writing messages in discussion forums as an ideal reflective process. Literature points out that intensive discussion and social interaction may lead to multiple knowledge construction phases (Hewitt, 2003; Schellens and Valcke, 2005; Bratitsis and Dimitracopoulou, 2008).

The literature suggests three factors that should be considered in planning an online discussion, the organization of the forum, the motivation of students to participate and the ability of students to participate effectively. Vonderwell and Zachariah (2005) found that the structure of the discussion forum is essential for successful learning and assessment. Brooks and Jeong (2005) suggest that online discussions should be organized into discussion topics and that within each topic there should be pre-established threads within which arguments are clustered. It is suggested that pre-structuring threads in this way may be an effective method of facilitating in-depth critical discussion. Where discussions are not threaded, discussion may become repetitive, thereby discouraging student participation (Wu and Hiltz 2004). The third consideration in planning online discussions is the ability of students to actively participate in the discussion at the required level. Salmon (2002) argues that a scaffolding approach needs to be taken to the facilitation of online activities so that students move through five stages of learning. The five stages are: access and motivation, online socialization, information exchange, knowledge construction and development. The crucial role of online activities at this stage is to promote and enhance reflection and maximize the value of online learning for the students (Salmon 2002). Reflection can be encouraged by posing reflective questions for students to address (Hulkari and Mahlamaki-Kultanen 2007; López Meneses and Vázquez-Cano 2013). This is referred to by Salmon (2002, 31) as the "spark" for the online activities. The questions should, where possible, refer to the subject content such as readings relevant to the question posed.

These two digital methodological strategies—design and implementation of MCMs and online discussion forums—can contribute significantly to the development of generic and specific strategies in the European Higher Education Area such as: self-regulated learning, communicative, instrumental and interpersonal competencies. These benefits are in agreement with Jonathan Grudin and Steven Poltrock (2012) who suggest that employing collaborative work as a strategy in Higher Education contributes to the enhancement of learning, allowing the sharing of different opinions and points of view, increasing the value of one’s own perspective and facilitating the exchange with course mates, since it activates and directs learning towards a successful approach to communicative situations among peers.

3. Description of the activities and cohort

This research project was developed in two phases. The first one was based on the development of MCMs in relation to social educators and social worker’s main intervention areas. These MCMs were prepared by students who attended the Information Technologies and Communication course as part of the Degree in Social Education and dual Degree in Social Education and Work during the academic years 2010-13 at Pablo Olavide University (Seville-Spain). The innovative experience consisted of encouraging introspective reflection by the students through concept maps used to identify and discuss the main social worker and social educator’s intervention areas with an interactive digital application called Mindomo (http://www.mindomo.com). This software enables social concept maps to be dynamically and easily designed. The university experiment was developed in groups (2-4 students) in class, working collaboratively from digital mobiles devices and personal computers to establish the main social worker and social educator’s intervention areas. For each intervention area, it was also requested to incorporate an image and a video in order to represent its meaning and socio-educational relevance. Once each MCM was finished, students inserted it over their own personal subject-blog and it was also sent to the general subject-blog http://mapasconceptualesestudiantes.blogspot.com.es/ (Figure 2). Students wrote a brief commentary.
(maximum 500 words) describing the main aspects of their MCM and included the following information: university degree, course, name and the link to their blogs. For fostering participation and collaborative work, it was possible to make comments about content and format in the MCM developed by each group of students in the online discussion forum.

Figure 2: Subject-blog. Source: [http://mapasconceptualesestudiantes.blogspot.com.es/](http://mapasconceptualesestudiantes.blogspot.com.es/)

In addition, to help students in the development of their own blogs, there were different electronic tutorials and word clouds to clarify concept map objectives and procedures developed by senior students from the previous academic years. Figure 3 is one example of these blogs made by students.

Figure 3: Multimedia concept map implemented by a university student. 2012/13. Source: [http://www.mindomo.com/mindmap/02818007b81f440aba391cbe9c62fed3](http://www.mindomo.com/mindmap/02818007b81f440aba391cbe9c62fed3)

Once the MCMs were finished and shared in the subject-blog, the second phase was developed. Students were asked to reflect on the categories and content showed in their MCMs. This phase was all done using an online discussion forum for active discussion. For the implementation of this phase, we used the free software "phpBB" ([https://www.phpbb.com/](https://www.phpbb.com/)). phpBB offers a completely modularized user control panel to give students full control over their account on the board. The main topics put forward in the forum were: analysis of Social Educator and Social Worker’s main areas of intervention. The forum was moderated by two professors and each student had to participate at least five times during the development of the subject. The topic proposed matched the two research dimensions stated in the first two objectives of the study.
The cohort that took part in this research project was comprised of students who attended the Information Technologies and Communication course as part of the Degree in Social Education and dual Degree in Social Education and Work during the academic years 2010-13 at Pablo Olavide University (Seville-Spain).

Table 1: Cohort

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4. Objectives

The main objectives of the research can be formulated as follows:

- To analyze Social Educator and Social Worker's main areas of intervention according to students' perceptions in the Information Technology and Communication Technologies (ICT) course during the academic years 2010-13.
- To study the diachronic evolution of Social Educator and Social Worker's main areas of intervention during the academic years 2010-13.
- To assess the effectiveness of didactic approaches with the use of MCMs and online discussion forums in social studies.

5. Method

The method was qualitative and descriptive for the analysis of MCMs and was based on social network analysis (SNA) for the analysis of participation in online discussion forums. For the analysis of first phase, 213 contributions in form of MCMs created by students were processed, analyzing words or clusters of meanings as registration units. Subsequently, the conceptual frame was transcribed and categorized taking as reference the guidelines established by different authors (Miles and Huberman 1994). This descriptive and qualitative part of the study was organized in two stages. Stage one was developed according to "data reduction" principles. It consisted of developing rational procedures as categorization and coding data, identifying and differentiating units of meaning. The procedures were: "data categorization" which involves simplifying and selecting information to make it more manageable. A process that involves "unit separation" to report segments following spatial, temporal, thematic and grammatical criteria. "Unit identification and classifying" was established to classify conceptually the units covered by a single topic with meaning. This procedure can be inductive while examining the data, or deductive, having previously established the categorization system, after reviewing literature on the specific field of study. Subsequently, we developed "synthesis and grouping processes". These processes complemented the last ones and enable the most representative categories to be re-categorized into meta-categories. To finish this first phase, the coding process was performed. It is a manipulative operation where each category is assigned to each textual unit. In this sense, each selected unit has been coded for frequency count through the computer-assisted qualitative data analysis software Atlas-Ti 7. From the start, there was clear criteria for distinguishing registration units, since most of the students chose three core concepts in each category. The second stage consisted in making the "Interpretation and inferences". The Atlas-Ti software facilitates the creation of data files to organize structured databases that can be analyzed using various qualitative techniques, such as clustering and categorization. For the development of this first phase, two coders were instructed to independently unitize the text messages.
Furthermore, the messages in online discussion forums were analyzed from the perspective of social network analysis (SNA); this methodology provides a relational approach following the reticular morphology of social connections. It enables an understanding of the form and structure of the relationships established as a whole, something which is essential in order to reach an understanding of the underlying mechanisms in the students’ statements in educational forums, facilitating hidden interaction patterns (Barabási 2002; Knoke and Yang 2008). SNA is based on the premise that the structures formed by the relationships among different elements provide a more thorough explanation of the whole, the social environment and also each of the elements than when their different traits are taken unitarily (Castells and Monge 2011; Caverlee, Liu and Webb 2010). Therefore, the procedure of using Atlas-Ti and a reticular SNA generates more complete results in order to understand relationships and opinions in virtual learning environments. With that aim this SNA methodology has been applied to identify text units that may justify the reasons declared by students when reflecting on main intervention areas. To this end the software UCINET 6 and the viewer yED Graph Editor 3.11.1 were used, with the aim of editing the graph and making it easier to understand. The matrix scheme used to generate the graph has been the following:

\[
\Pr(Y = y) = \left(\frac{1}{\kappa}\right) \exp\left\{\sum_{A} n_{A}g_{A}(y)\right\}
\]

Where \(n_{A}\) is the corresponding configuration A parameter (whose outcome cannot be zero if all pairs of variables in A are assumed to be "conditionally dependent"). Also, \(g_{A}(y) = y_{ij}I_{Ay_{ij}}\) is the statistical network configuration corresponding to A; \(g_{A}(y) = 1\) if it coincides with the observation "and" on the network, and if the network does not appear in the result is 0. \(\kappa\) is an amount that ensures standardization (1) is a proper probability distribution. All models of exponential random graphs take the form Eq. (1) which implies a general probability distribution of graphics in "n" nodes considering that there are different assumptions dependence with the consequence of choosing different types of configurations as relevant to the model. Considering this equation, the only configurations that are relevant for the model are those in which all possible links are mutually configuration contingent with each other.

6. Results

The first qualitative phase was analyzed with the participation of two coders who were instructed to independently unitize the MCMs’ text messages. After a first round of unitizing, inter-coder reliability-measures were calculated. We calculated Guetzkow’s U, which measures the reliability of the number of units identified by two independent coders, as follows (Holsti 1969):

\[
U = \frac{(O_{1} - O_{2})}{(O_{1} + O_{2})}
\]

O1 represents the number of units identified by coder 1, and O2 the number of units identified by coder 2. After the first unitizing run, Guetzkow’s U equaled .0077, showing almost 100% conformance in the number of units identified by the coders. To check textual consistency of the identified units (Weingart et al. 1990), inter-coder unitizing reliability was additionally calculated (compared electronically units of coder 1 and coder 2 using the Excel-program). In our case, textual consistency was as high as 85.31% in the first round, which is considered an excellent result (Simons 1993). Using these main categories and the respective subcategories (total: 17 categories), the two coders independently assigned a single code to each unit. After this first main coding round, we calculated Cohen’s kappa to check inter-coder reliability. The basic version of Cohen’s kappa suggested by Brennan and Prediger (1981) that we used is calculated as follows:

\[
\kappa = \frac{(\sum_{i} p_{ii} - \sum_{i} p_{i} \times p_{i})}{(1 - \sum_{i} p_{i} \times p_{i})}
\]
Table 2: Results for Inter-coder Consistency-Matrix

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<td>Total</td>
<td>515</td>
<td>349</td>
<td>376</td>
<td>421</td>
<td>514</td>
<td>332</td>
<td>220</td>
<td>276</td>
<td>172</td>
<td>174</td>
<td>252</td>
<td>150</td>
<td>187</td>
<td>124</td>
<td>198</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

Agreement (Ag.) values are shown. Percentages are calculated as cases * 100 / total cases for each category.

We found a relatively middle-high coding correspondence of κ = .85.58 Kappa values above .80 are generally considered a very good result (Brett et al. 1998). This value is relatively high compared to results reported in other studies and can be considered as highly satisfactory (Lombard, Snyder-Duch and Bracken 2002). The results obtained after data encoding and information interpretation show that university students have established an average of 4.16 concepts associated with the main areas of social educator and worker’s interventions areas. According to students’ conceptions, we found a terminological combination, in which some population sectors obtain beneficial actions associated with the social educators and workers interventions, such as children, youth, elderly, homeless, immigrants, with the main intervention areas (socio-cultural, drug addiction, domestic violence, prostitution, prison, social-community attention, etc.). Leaving aside this conceptual fusion, percentages are shown in Table 3.

Table 3: Main intervention areas in social educator and social worker jobs

<table>
<thead>
<tr>
<th>Areas of intervention</th>
<th>% Cases</th>
<th>Nb Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood - teens at risk</td>
<td>63%</td>
<td>328</td>
</tr>
<tr>
<td>Seniors</td>
<td>67%</td>
<td>349</td>
</tr>
<tr>
<td>Adults - long life learning</td>
<td>38%</td>
<td>198</td>
</tr>
<tr>
<td>Disability/handicap</td>
<td>50%</td>
<td>260</td>
</tr>
<tr>
<td>Drug dependence</td>
<td>63%</td>
<td>328</td>
</tr>
<tr>
<td>Mental health</td>
<td>31%</td>
<td>162</td>
</tr>
<tr>
<td>Community care / social services</td>
<td>11%</td>
<td>57</td>
</tr>
<tr>
<td>Socio-cultural animation</td>
<td>24%</td>
<td>125</td>
</tr>
<tr>
<td>Special education</td>
<td>8%</td>
<td>42</td>
</tr>
<tr>
<td>Family</td>
<td>2%</td>
<td>10</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>15%</td>
<td>78</td>
</tr>
</tbody>
</table>
### Table: Student Perceptions of Main Intervention Areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeless</td>
<td>4%</td>
<td>21</td>
</tr>
<tr>
<td>Minorities</td>
<td>3%</td>
<td>16</td>
</tr>
<tr>
<td>Prison</td>
<td>8%</td>
<td>42</td>
</tr>
<tr>
<td>Prostitution</td>
<td>3%</td>
<td>16</td>
</tr>
<tr>
<td>Social welfare</td>
<td>5%</td>
<td>26</td>
</tr>
<tr>
<td>Immigrants</td>
<td>21%</td>
<td>109</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>2167</strong></td>
</tr>
</tbody>
</table>

By analyzing the percentages, we can highlight the following areas: Seniors (67%), childhood-adolescence along with drug dependence (63%), disability (50%), adults (38%), mental health (31%), socio-community attention (24%) and immigrants (21%). Other areas that students have identified as the highest priority for intervention in Social Education and Social Work are: domestic violence (15%), socio-community care (11%), special education and prison (8%), social welfare (5%), homeless people (4%), prostitution and other minorities in general (3%) and family (2%).

One interesting result is to compare diachronically the students' perceptions about main intervention areas along the three academic years. This evolution gives us useful information about how students perceive the intervention areas along their university studies and the influence of the development of the different university subjects. These diachronic results can be observed in Figure 4.

During 2010/11, attention to the children and adolescents at risk was the most relevant period considered by students (81%). During the academic year 2011/12 it did not have much importance (44%), in the year 2012/13 this was recorded again as more important (63%).

- The same graph shows the areas of elderly care (73% in 2010/11, 54% in 2011/12 and 83% in 2012/13), adults (46% in 2010/11, 23% in 2011/12 and 52% in 2012/13), mental health (35% in 2010/11, 22% in 2011/12 and 41% in 2012/13).

- However, in the areas of disability (46% in 2010/11, 43% in 2011/12 and 72% in 2012/13) and drug dependence (61% in 2010/11, 61% in 2011/12 and 72% in 2012/13), we found that these areas remain stable during the first years and increase during the last years.

On the other hand, we highlight the references to areas that increase along the academic years, such as community care and social services (18% in 2010/11, 22% in 2011/12 and 43% in 2012/13), gender violence that happens to be marked by 9% of students in 2010/11 to 21% and 17% in subsequent courses. As with the issue of immigration, increasing from 9% to 35% and 20%, homeless (0% in 2010/11, 3% in 2011/12 and 13% in 2012/13). On the opposite side, specialized education decreases on students' consideration throughout the academic years, from 10% in 2010/11, 7% in 2011/12 and 4% in 2012/13.
Figure 4: Intervention areas evolution along three academic years

This qualitative and descriptive study was complemented with the analysis of the perceptions, commentaries and opinions of the students in the two topics of the forums. Some of these areas have been delimited by students in online discussion forums, as follows:

**Children, adolescents:** Childhood’s educational intervention has, as a main objective, to support young people with family, educational and emotional basic needs through a social action with the child and his/her family to prevent non-adaptive behaviors. In the area of childhood, adolescence and youth we can highlight youth hostels, youth houses, educational farms, playgrounds, play centers, youth information points, environmental education centers, open centers, shelters for children and teenagers, and adoption services, among others [P56-123].

**Seniors:** The intervention with the elderly is important to design interventions adapted to the different needs of this population and consider the contexts and environmental factors that make people age. Thus, it is necessary to recognize other factors besides health as determinants of aging. In this area, we can name: day centers, residential centers, sheltered accommodation, home help services and leisure areas [P25-23].

**Adults:** Social educator has to be involved in the normalization of everyday life [P91-87].

**Disability:** Social educator proceeds to develop intervention programs to avoid their marginalization in the society in which they live [P67-12].

**Drug dependence:** Drug addiction is related with three main social educator’s intervention areas: primary prevention to avoid consumption, secondary prevention when the subject has already had contact with drug and tertiary prevention (Harm Reduction) for dependency cases. In this last scenario the agent would try to prevent the situation from worsening and seek to reduce the risks associated with consumption (spread of infectious diseases such as HIV or hepatitis, overdose risk, etc.) [P89-101].

**Mental health:** In the current psychiatric care, the involvement of interdisciplinary teams composed of different professionals is a priority. Psychologists, social workers, and more recently, the incorporation of social workers to these teams [P159-45].

**Gender violence:** The social educator shall make them see that they should not be afraid or ashamed to express how they feel and say what they are going through [P123-78].
Immigration: Thousands of people are risking their lives or become indebted to mafias to find a better place in which to live and work to raise their families, many of them are rejected or excluded by the society of the country they migrated to. In this area many other problems come into play, sometimes closely related to prostitution or human trafficking [P89-45].

Homelessness: Different situations like evictions, illness, loneliness, etc. force many people to live on the streets. Society rejects and ignores these people, sometimes thinking they chose that situation or have deserved for several reasons. As more and more people are in this situation, educators and social workers have to help them to get out of that difficult situation in which they are [P12-47].

In order to develop a more systematic approximation to students’ participation we analyzed from the perspective of social networking analysis (SNA), the network of interactions obtained in the topics of the online discussion forum with the most significant connections. Therefore, we edited the final UCINET and Netdraw network using the yED Graph Editor 3.11.1 (Figure 5) in order to make it more visual and comprehensible.

Figure 5: Intervention areas network

We can observe in yellow color the central threads of the forums. The average density of the two threads of the forum with the dichotomized matrix was .55 with .24 of standard deviation; which represents a high value for a sample of 196 students and an average rang of the network of 3.521; which indicates that the key word is interrelated with the average of about 3. This a high value for a total of 28 nodes. According to Figure 5, among the active participants who scored above average (Ave = 3.52) in the number of posts they contributed, all contributed a variety of entries that served different functions in the discussion thread. At the same time, these active participants also received diverse types of feedback from other members within the community. Almost everyone in the discussion acknowledged, directly replied to and commonly interpreted other members’ posts in writing. Additionally, the majority of participants received acknowledgement, replies and interpretations of their posts from other members. There was also a good balance among types of participation each member engaged with and the types of feedback each member received.
Moreover, this result shows that more than two thirds of the possible connections were present and that a high level of participation was obtained. We have analyzed the centrality of the network to identify the most prominent aspects. To this end, we have referred to the analysis of the nodal value of intermediation and proximity (Table 4).

**Table 4:** Nodal value of intermediation and proximity in the online discussion forums

<table>
<thead>
<tr>
<th>Intervention areas</th>
<th>Nodal Grade</th>
<th>Betweenness Grade</th>
<th>Closeness Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood - teens at risk</td>
<td>20.0</td>
<td>54.550</td>
<td>64.5</td>
</tr>
<tr>
<td>Seniors</td>
<td>21.0</td>
<td>56.275</td>
<td>66.0</td>
</tr>
<tr>
<td>Adults - long life learning</td>
<td>15.0</td>
<td>46.250</td>
<td>57.5</td>
</tr>
<tr>
<td>Disability/handicap</td>
<td>18.0</td>
<td>49.750</td>
<td>61.0</td>
</tr>
<tr>
<td>Drug dependence</td>
<td>20.0</td>
<td>53.225</td>
<td>63.0</td>
</tr>
<tr>
<td>Mental health</td>
<td>14.0</td>
<td>43.750</td>
<td>52.0</td>
</tr>
<tr>
<td>Community care / social services</td>
<td>11.5</td>
<td>35.750</td>
<td>32.5</td>
</tr>
<tr>
<td>Socio-cultural animation</td>
<td>9.0</td>
<td>27.750</td>
<td>39.5</td>
</tr>
<tr>
<td>Special education</td>
<td>7.0</td>
<td>25.500</td>
<td>35.0</td>
</tr>
<tr>
<td>Family</td>
<td>1.0</td>
<td>2.500</td>
<td>10.0</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>13.0</td>
<td>38.500</td>
<td>52.0</td>
</tr>
<tr>
<td>Homeless</td>
<td>2.0</td>
<td>3.500</td>
<td>11.0</td>
</tr>
<tr>
<td>Minorities</td>
<td>2.5</td>
<td>4.500</td>
<td>11.5</td>
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<tr>
<td>Prison</td>
<td>7.0</td>
<td>25.500</td>
<td>39.0</td>
</tr>
<tr>
<td>Prostitution</td>
<td>3.0</td>
<td>4.500</td>
<td>12.0</td>
</tr>
<tr>
<td>Social welfare</td>
<td>2.5</td>
<td>4.500</td>
<td>11.5</td>
</tr>
<tr>
<td>Immigrants</td>
<td>10.5</td>
<td>28.500</td>
<td>38.0</td>
</tr>
</tbody>
</table>

Our discussion thread topology illustrated three types of dynamics, the short thread pattern that consists of one post and one reply only; the extended thread pattern that consists of several consecutive posts corresponding with the previous post and the branched thread pattern where multiple replies were made to a single post. This last pattern has the highest nodal degree (Table 4). The centrality shows the position of the concepts featured in the network and reveals a rather high result of 63% with a total number of 25 nodes. The maximum value (maximum number of connections of a node in the network) is 12 (Childhood) forming nodes 18 to 20 (disability/handicap, drug dependence and seniors), the nucleus of the graph, according to the concept of "k-cores". The results show that the aspects with the highest normalized degree (Nrmdegree: percentage of connections that have a node above the total of the network). The results of the intermediation 51,202 provides us relevant information regarding the frequency with which a node appears in the shortest circuit (or geodesic) which connects to the other two, in other words, showing when a topic can be an intermediary amongst others. We have reported in the facilitator group those nodes which have a higher degree of intermediation (≥20) and that reoccur in the three analyzed dimensions. The results of the degree of
proximity indicate that these bigger nodes are concentrated in those aspects which serve to interrelate the main intervention areas marked in yellow color (Table 4).

7. Discussion

Combining the suggested qualitative procedure of content analysis with the subsequent categorization of network of interactions in online discussion forums through social networking analysis (SNA), we were able to shed light on the various types of main intervention areas derived from a diachronic perspective during three academic years.

Among the main results drawn upon the diachronic study of academic courses emphasize, in the first instance, that the development of concept maps media developed by the student have been used to meet the first two objectives of our study, the diachronic evolution of the areas of intervention of the social educator and social worker, showing that there is an increase over academic years, such as community care and social services (18% in 2010/11, students 22% in 2011/12 and 43% in 2012/13), gender-based violence that happens to be marked by 9% of students in 2010/11 to 21% and 17% in subsequent courses. As with the issue of immigration, increasing from 9% to 35% and 20%, homeless (0% in 2010/11, 3% in 2011/12 and 13% in 2012/13). These results are in line with results in other studies (Kearney, et al. 2000; British Association of Social Workers 2002; Cunningham 2004). Thus, social workers and educators are not the only professionals likely to be working with individuals and families in different circumstances. Indeed, in the nature of the complexities, interactions and risks involved, many people will also be dealing with other professional groups from the health, education, housing, employment and justice services. The research suggest students' perceptions and priorities when developing these protection procedures from main intervention areas. These students' priorities reflect, in part, the eight Millennium Development Goals (European Parliament Council Commission 2006) based on the eradication of extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce the mortality rate of children; improve maternal health; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability and develop a global partnership for development.

According to objective three, the work and study through MCMs and online discussion forum can significantly facilitate the tasks of a teacher, as we can see in other studies (Bratitsis and Dimitracopoulou 2008). Students' participation in online forum can support critical thinking through interactions, taking place within asynchronous discussions, in order to achieve high quality learning outcomes. With this activity, students have developed inner understanding of social educators and social workers' areas of intervention from an holistic point of view and a self-regulation approach. This approach has revealed the importance of intense interaction among discussions' participants, as a prerequisite for the development of **critical thinking** and **knowledge construction**, also reported in other studies (Bratitsis & Dimitracopoulou 2008).

It was discovered that the students' familiarity and interest in the topic affected the dynamics of participation (Gao, Zhang & Franklin, 2013). The majority of the discussion was composed of acknowledgement, interpretation, and reply. Results in online forums showed that the main topics developed with highest Nodal Degree were: Seniors (21), Childhood - teens at risk (20), Drug dependence (20), Disability/handicap (18), Adults - long life learning (15), Mental health (14), Domestic violence (13) and Community care / social services (11,5).

The results also showed that students usually question when they are posting disagreements towards their peers, and usually reiterate the other person’s opinion before acknowledging each other. The results suggest that both active and passive participation have merits in terms of learning. Active participation allows participants to practice and showcase their critical thinking skills, while passive participation allows member to gain more insights from the entries contributed by the other members. According to Figure 5, most members of this discussion community completed information exchange at least once, but the entire class failed to form one complete strongly connected component. There were 5 individuals who were left as independent components, while the rest of the class formed a complete strongly connected component.

Furthermore, evidence of improvement in the students' behavior during dialogic activities has also been reported as we can see in SNA results. Students were tighter connected with their partners in the online discussions and the participation pattern of most of the experimental groups' students was much more widely spread within the discussion threads. Then, the teacher would have the opportunity to select the indicators
more suitable to the designed activity, further decreasing his/her work load, by transferring a portion of the regulative tasks to the users (Bratitsis and Dimitracopoulou 2008).

Acknowledgements

This research is part of a big research called: "Didactic training in Cloud Computing: Digital skills, teaching strategies and e-activities with Web 2.0 technology in the EHEA", under Action 2 of Innovation Projects and Faculty Development funded by the Department for Teaching and European Convergence of Pablo de Olavide University (Seville-Spain).

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Student Response (clicker) Systems: Preferences of Biomedical Physiology Students in Asian Classes

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Abstract: Student response systems (commonly called ‘clickers’) are valuable tools for engaging students in classroom interactions. In this study, we investigated the use of two types of response systems (a traditional clicker and a mobile device) by students in human physiology courses. Our results showed high student satisfaction with the use of clickers in class. A survey also provided insights into how students perceived the benefits of response systems. We found that most students favoured the use of traditional clickers over mobile clickers, with the students reporting a number of difficulties in using the latter. These difficulties could discourage students from moving ahead to more advanced levels in programmes that involve mobile device interaction with the course teacher. Thus, innovations in learning technology should proceed with caution, and with constant attention given to students’ preferences and needs.

Keywords: Web-based response system, clickers, student perception, human physiology, classroom interaction

1. Introduction: The use of clickers in classrooms

Student-teacher interaction has been deemed an essential part of the learning process (Siau, Sheng & Nah 2006) with a strong influence on student performance. Good interaction in the classroom can foster better learning attitudes and higher achievement (Haseman, Polatoglu & Ramamurthy 2002). A classroom environment can include multiple interaction types, including student-instructor, student-student and student-content (Moore 1989), that exhibit varying efficacy in each learning situation. For example, in a student-instructor interaction in the classroom setting, the instructor can gauge the students’ understanding of the content by asking them questions, and the students can raise their hands to answer. However, some students may not be willing to answer due to shyness (Ayu, Taylor & Mantoro 2009; Mula & Kavanagh 2009) or fear of being wrong (Voelkel & Bennett 2014). An audience response system can be helpful in this situation, as it allows students to answer questions anonymously rather than in the conventional way.

At present, there are two main types of response systems: the traditional clicker and the more recently developed Web-based device. Both systems involve similar clickers comprising three main components: an answer keypad with a signal emitter (fused into a single unit), a signal receiver and a processing unit. The answer keypad allows students to input their answers, which are sent by the emitter to the processing unit. In the traditional system, as noted by Stav, Nielsen, Hansen-Nygard and Thorseth (2010), the keypad-emitter component is a clicker device, whereas in the Web-based system it is usually a mobile phone. The signal receiver (placed in the classroom) collects the signals emitted by the clickers in the traditional system, or the signals are transmitted through a phone or Internet network in the Web-based system. The signal receiver also sends the signals to the processing unit for analysis. The processing unit – typically a computer in the traditional system and a server in the Web-based system – analyses the signals received and generates statistical results using the system’s operating software or an installed program.

Numerous empirical studies on the use of traditional response systems have generally reported positive responses from users. For example, the findings from Alexander, Crescini, Juskewitch, Lachman and Pawliwa (2009), Fifer (2012), Olaga and Keengwe (2013) and Vana, Silva, Muzyka and Hirani (2011) indicated that students had favourable perceptions of the usefulness of clicker systems during lessons. The subjects of these studies were students taking courses in the anatomical sciences, nursing (two of the studies) and physical geography. The sample sizes in the four studies ranged from 24 to 78 students. The participants were provided with clicker sessions during their classes in which questions were displayed and answered with clickers. The students’ feedback on the use of clickers was then collected by surveys. The surveys showed a range of positive responses concerning the helpfulness of clickers in class. Some students reported that the clickers helped them to maintain concentration, and that using the clickers was enjoyable (Fifer 2012). Others noted that the clickers were easy to use, and that the immediate feedback from the instructor helped them to understand the concepts being taught (Olaga & Keengwe 2013). Some of the participants said that the clicker system increased their comprehension and retention of the lecture content (Vana et al. 2011). Others said that the clicker system helped them review the material presented (Alexander et al. 2009).

Despite these advantages of traditional clickers reported in previous studies, the devices do have the following disadvantages:

- instructors must buy the clickers and their batteries, making it a costly system to purchase and maintain (Gok 2011); and
- the instructors must take the time to distribute and collect the clickers (Jones, Marsden & Gruijters 2006).

The newer, Web-based response systems address these problems, as mobile phones are used as both the answer keypads and signal emitters. Stav et al. (2010) remarked that such Web-based systems are likely to reduce the costs associated with dedicated clicker devices, enabling institutes such as the University of Austin (Moca 2009) to build their own systems instead of paying for the traditional commercial ones.

The various Web-based student response systems generally use one or more of the following methods for students to cast votes using their mobile phones: (i) dialling, (ii) sending short message service (SMS) texts, (iii) accessing a polling website or (iv) using a polling application (app). With method (i), a specific phone number is assigned to each multiple-choice answer and the students answer by dialling the corresponding number. With method (ii), the students can send their chosen answer as an SMS text to the number provided. With method (iii), the students can access a polling website with a mobile phone that has Internet and Web-browsing capabilities, and then select the answer on the webpage. With method (iv), the students can connect to the polling server through a mobile phone app and answer the instructor’s questions.

The potential of mobile (Web-based) clicker systems has become an interesting topic for discussion among instructors and students, with general agreement that they achieve effects similar to those attained by traditional systems. Two empirical studies have explored the use of SMS messaging (type ii) Web-based systems, and their evaluation results were positive. In Tremblay’s (2010) study, the students reported that the system made their classes more interactive and less boring. They also said that they enjoyed using their mobile phones to participate. In Voelkel and Bennett’s (2013) study, the students reported that the system made their classes more interesting, encouraged them to accept feedback on their learning and provided a good way to break lectures into sections, with brief interactive reviews of the material presented. Arnesen, Korpas, Hennissen and Stav (2013) studied a Web-based student response system (type iii) and found increased learning outcomes, particularly among students who were low-achievers in the class.

Another area of discussion concerns the advantages of the mobile phone clicker system over the traditional system, in that no special equipment or maintenance costs are required and the system can be used by distant learners (Jagar, Petrović & Pale 2012; Lapp, Ringenberg, Summers, Chivukula & Fieszar 2011). Some observers have noted that a Web-based system allows teachers to ask opened-ended questions instead of just multiple-choice questions (Lapp et al. 2011). The newer systems also offer additional possible functions such as anonymous or authenticated polling (Llamas-Nistal, Caieiro-Rodriguez & Gonzalez-Tato 2012).

In considering the advantages of mobile clickers described in the literature, we foresee that this system could become popular in Hong Kong classrooms. In addition, we think that the high penetration rate of smartphones in Hong Kong (58% in 2012) (Nielsen Company 2012, 2013) and the popularity of 3G/4G service (8.86 million
subscribers in Hong Kong in 2013) (Information Services Department 2013) provide favourable conditions for the use of mobile clickers in classrooms.

The operating software used in our context is a commercial ‘hybrid’ system called ResponseWare, purchased from TurningPoint Technologies. It is a ‘hybrid’ (both traditional and Web-based) in the sense that students can answer using dedicated clickers distributed by the teacher, but if the teacher desires and students have access, other mobile devices can be used to access a webpage and answer through the web interface (type iii) or a dedicated app (type iv). As with the traditional clicker system, this software works with MS PowerPoint. The students can download a dedicated ResponseWare app and install it on their smartphones, or go to the ResponseWare website using a standard browser. Before answering questions, the students must enter a session ID number that matches a question session created by the teacher online. Whether the students enter their names is optional, and the results of their responses are shown in a bar chart immediately after each question.

Classroom use of innovations can be challenging. Lam, Wong, Mohan, Xu & Lam (2011) noted some of the earlier issues with using Web-based student response systems, including the fact that not all students have smart phones with the necessary capabilities. Likewise, some teachers and students lack the proper technical knowledge to use such systems. We regard this study as another pilot trial in the use of this system, and aim to identify additional beneficial or adverse effects. Yet the advantages of response systems, be they traditional or Web-based, have been recognised by an increasing number of teachers, some of whom have shown a strong interest in trying them in their courses. This study considers the results of a trial using the two types of response systems in a series of courses related to the biomedical sciences and Chinese medicine. Our objective is to explore the students’ perceptions of the traditional and Web-based response system types.

2. Background

Our study participants were biomedical students from five physiology courses offered at the Chinese University of Hong Kong from 2010–2011 and 2011–2012. The participants were majoring in a variety of biomedical and medical disciplines, including pharmacy, nursing, Chinese medicine and human biology, and most were in the first year of a three-year curriculum (see Table 1). The majority of the participants, with the exception of the human biology students, had never been exposed to any form of clickers. With the support of a special internal grant, we purchased 200 traditional clickers and began a pilot study in 2010 by gradually introducing them into selected physiology courses with small class sizes.

We expected the use of clickers to transform the learning dynamics of these courses and facilitate a multi-dimensional teaching mode to improve student learning, especially in courses with large classes. In an earlier study (2009), we received overwhelmingly positive responses from students in smaller classes (data not shown). Thus, from 2010 to 2012, we implemented the use of clickers in additional classes with larger numbers of students (see Table 1).

Table 1: Course Information for 2010–2011 and 2011–2012

<table>
<thead>
<tr>
<th>Student Majors</th>
<th>Programme Type (Undergraduate - U, or Postgraduate – P)</th>
<th>Year</th>
<th>(2010–2011)</th>
<th>(2011–2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total number of students</td>
<td>Total number of students</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>U</td>
<td>1</td>
<td>79</td>
<td>88</td>
</tr>
<tr>
<td>Nursing</td>
<td>U</td>
<td>1</td>
<td>196</td>
<td>202</td>
</tr>
<tr>
<td>Nursing</td>
<td>P</td>
<td>1</td>
<td>59</td>
<td>83</td>
</tr>
<tr>
<td>Chinese Medicine</td>
<td>U</td>
<td>1</td>
<td>41</td>
<td>32</td>
</tr>
<tr>
<td>Food/Nutritional Sciences/Human Biology</td>
<td>U</td>
<td>2</td>
<td>45</td>
<td>82</td>
</tr>
</tbody>
</table>

*Due to the course arrangement, in 2011–2012, the students majoring in Food and Nutritional Sciences were combined with those in Human Biology.
Students studying human physiology sometimes encounter difficulties in understanding the long, complicated molecular and physiological mechanisms and the complex ways in which human organs coordinate. The use of clickers in our participating classes was thus intended to provide students with opportunities to:

- review a summary of the topic-specific concepts and theories presented in class,
- consolidate their knowledge of facts about selected body organ systems,
- identify their topic-specific weaknesses and common mistakes,
- allow immediate discussion with the teacher and
- facilitate an interactive atmosphere in class.

Clicker question slides were shown to the students at the end of each topic’s lecture series. In most cases, the students were encouraged to discuss the questions with their classmates for a minute, after which they selected their answers from the given options. A histogram of how the students responded to each question showed up immediately, along with the correct answer. The teacher would then initiate a discussion or elaborate on the question, and the students could ask further questions. In this way, the students could consolidate their grasp of the contextual concepts and check their understanding with the teacher. The teacher was also able to identify the students’ major weaknesses and provide immediate feedback.

Given the increasing popularity of mobile smart devices among university students (such as smartphones, iPads and Android tablets), students are often assumed to be willing and ready recipients of new information technology and gadgets. We expected a favourable transition from traditional clickers to systems using mobile devices. We asked two classes, each with a moderate number of students, to answer some clicker questions at the end of their lectures using their smart phones or other mobile devices with Internet connections. The students were first given a few minutes’ introduction on how to log into the mobile software system. Those who did not own a smartphone were given a traditional clicker to log into the system at the same time. After the clicker session, the students were given a survey form to evaluate the experience.

2.1 Situation 1: Use of traditional clickers

In our first study (2010–2011 and 2011–2012), students from all of the selected courses used traditional clickers (see Table 2). The number of clicker questions was limited to a maximum of five to eight after each lecture to ensure sufficient time for class discussion. More clickers were used in the 2011–2012 period due to requests from students in various courses. For each lecture involving a clicker session, traditional clickers were distributed to students at the beginning of class. The operation software used for the system was XPRESS from the Sun-Tech International Group Limited. This system articulated the student responses in the form of MS PowerPoint bar-chart slides, which appeared immediately after all responses were received for each question. The teachers procured the supply of clickers and receivers from a local rental service.

Table 2: Percentage of Lectures that Used Traditional and Mobile Clickers

<table>
<thead>
<tr>
<th>Student Majors (2010–11)</th>
<th>Total no. of lectures</th>
<th>No. of lectures that used clickers (T = traditional, M = mobile)</th>
<th>% of lectures that used clickers</th>
<th>Student Majors (2011–12)</th>
<th>Total no. of lectures</th>
<th>No. of lectures that used clickers (T = traditional, M = mobile)</th>
<th>% of lectures that used clickers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmacy</td>
<td>38</td>
<td>3T</td>
<td>7.89</td>
<td>Pharmacy</td>
<td>38</td>
<td>3T</td>
<td>7.89</td>
</tr>
<tr>
<td>(Bachelor)</td>
<td>22</td>
<td>2T</td>
<td>9.09</td>
<td>(Bachelor)</td>
<td>22</td>
<td>3T</td>
<td>13.68</td>
</tr>
<tr>
<td>Nursing (Master)</td>
<td>35</td>
<td>3T</td>
<td>8.57</td>
<td>Nursing (Master)</td>
<td>35</td>
<td>8 (7T, 1M)</td>
<td>22.86</td>
</tr>
<tr>
<td>Chinese Medicine</td>
<td>20</td>
<td>3T</td>
<td>15.00</td>
<td>Chinese Medicine</td>
<td>20</td>
<td>4T</td>
<td>20.00</td>
</tr>
<tr>
<td>Human Biology</td>
<td>34</td>
<td>3T</td>
<td>8.82</td>
<td>Human Biology</td>
<td>34</td>
<td>6 (5T, 1M)</td>
<td>17.65</td>
</tr>
</tbody>
</table>
2.2 Situation 2: Use of Web-based mobile clickers

Two courses in human biology and nursing (year 1 of a Master’s programme) in 2011–2012 (see Table 2) were selected for the Internet-based response system trial. These two classes were of moderate size, and their students showed relatively higher ownership of smartphones or mobile devices with the necessary capabilities. Students who were already accustomed to using traditional clickers from previous classes were given a short introduction on operating the Web-based clicker system, including how to connect to the online software for the mobile clickers using their mobile devices. Students who did not own mobile devices with Internet connections were provided with traditional clickers that could also connect to the polling server, thanks to our previously explained ‘hybrid’ system. In both participating courses, the response sessions involved a maximum of five questions.

3. Findings

In both the traditional clicker and Web-based device situations, evaluation surveys were administered at the end of the courses to collect the students’ feedback on the experience of using clickers in class. Table 3 summarises and contrasts the students’ scores in the two situations. For Situation 1, we collected data from six classes, and for Situation 2, we collected data from two classes.

Table 3: Student Feedback (Multiple Choice Questions)

<table>
<thead>
<tr>
<th>Main themes and question numbers</th>
<th>Question items</th>
<th>Situation 1</th>
<th>Situation 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean scores</td>
<td>N</td>
</tr>
<tr>
<td>Process</td>
<td>Participation with clickers increased my interaction with the instructor.</td>
<td>4.07</td>
<td>317</td>
</tr>
<tr>
<td>Q1</td>
<td></td>
<td>4.18</td>
<td>115</td>
</tr>
<tr>
<td>Q2</td>
<td>Participation with clickers increased my interaction with other students.</td>
<td>3.80</td>
<td>318</td>
</tr>
<tr>
<td>Q3</td>
<td>Using clickers improves class participation.</td>
<td>4.14</td>
<td>317</td>
</tr>
<tr>
<td>Q4</td>
<td>Using clickers allows me to pay more attention during lectures.</td>
<td>3.95</td>
<td>318</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.00</td>
<td>115</td>
</tr>
<tr>
<td>Understanding</td>
<td>Answering clicker questions during lectures helped me to clarify whether I understand course concepts.</td>
<td>4.27</td>
<td>317</td>
</tr>
<tr>
<td>Q5</td>
<td></td>
<td>4.26</td>
<td>115</td>
</tr>
<tr>
<td>Q6</td>
<td>Using clickers encouraged me to come to class better prepared.</td>
<td>3.69</td>
<td>308</td>
</tr>
<tr>
<td>Q7</td>
<td>I believe that I learned more in this class due to the use of the clickers.</td>
<td>3.93</td>
<td>318</td>
</tr>
<tr>
<td>Q8</td>
<td>Using clickers gave me immediate feedback about my understanding of a concept.</td>
<td>4.26</td>
<td>316</td>
</tr>
<tr>
<td>Q9</td>
<td>Using clickers encouraged me to really understand the materials rather than</td>
<td>4.00</td>
<td>316</td>
</tr>
<tr>
<td>Q10</td>
<td>Using clickers helped me to apply the concepts during class.</td>
<td>4.00</td>
<td>316</td>
</tr>
<tr>
<td>Q11</td>
<td>Using clickers helped me to identify misunderstandings and misconceptions in my thinking while in class.</td>
<td>4.17</td>
<td>317</td>
</tr>
</tbody>
</table>

**Attitudes**

| Q12 | I enjoyed participation with clickers. | 4.06 | 317 | 4.07 | 115 |
| Q13 | I would like my instructor to ask more clicker questions. | 3.94 | 317 | 4.00 | 115 |

**Overall comments**

| Q14 | I would recommend using clickers again in this course. | 4.19 | 317 | 4.21 | 115 |
| Q15 | Clickers make classes more interesting and fun. | 4.04 | 316 | 4.14 | 114 |
| Q16 | Using clickers in class helped me to do better in quizzes and exams. | 3.83 | 317 | 3.83 | 115 |
| Q17 | I would prefer that my other courses also used clickers. | 4.05 | 317 | 4.06 | 115 |

**Difficulties***

| Q18 | I experienced technical problems with the clicker during class. | 2.54 (original); 3.46 (converted) | 316 | 2.99 (original); 3.01 (converted) | 114 |
| Q19 | The instructor experienced technical problems with the clicker during class. | 2.43 (original); 3.57 (converted) | 317 | 2.87 (original); 3.13 (converted) | 114 |
| Q20 | The clicker session was time consuming. | 2.60 (original); 3.40 (converted) | 317 | 2.92 (original); 3.08 (converted) | 115 |
| Q21 | It was difficult to see whether my clicker was working or not. | 2.37 (original); 3.63 (converted) | 316 | 2.66 (original); 3.34 (converted) | 115 |

* As questions on this theme were written in the opposite direction to that used for the other themes, a lower score means a more positive response (marked as ‘original’). For a better comparison with other questions,
these scores are also converted according to the scale used with the other themes (with the translated score marked as ‘converted’).

### 3.1 Learning benefits

The overall response rate of the six classes in Situation 1 was 63.0%, and the range was 31.1-89.8%. The scores ranged from 3.40 to 4.27, which indicated that the students were mildly positive towards the use of clickers in class. In Situation 2, the response rate for the human biology programme was 44.0%, and for the nursing programme it was 96.2%. The scores ranged from 3.01 to 4.26, which also indicated that the students were mildly positive towards the use of clickers in class. Note that these results represent the overall feedback on the use of both types of clickers. They do not indicate which type of clicker was rated better, because we did not ask the students which type of clicker they used in the survey.

In Situation 1, the students perceived that the most prominent advantage of using clickers in class was that they helped identify misconceptions, which clarified the knowledge presented. Of the seven questions on the theme of ‘understanding’, five (Q5, Q8, Q11, Q9 and Q10) had mean scores of 4 or higher (4.27, 4.26, 4.17, 4.00 and 4.00, respectively). The second major advantage was that the clickers encouraged the students to engage in the lesson. Two of the four questions in the ‘processes’ theme (Q1 and Q3) had scores higher than 4 (4.07 and 4.14, respectively). The responses on the ‘overall comments’ theme (Q14, Q17 and Q15) indicated that the students’ willingness to use clickers was also quite high (4.19, 4.05 and 4.04, respectively). Likewise, most of the students claimed to enjoy using the clickers (Q12, 4.06, in the ‘attitudes’ theme). The questions about the clickers’ ease of use got the lowest scores, but remained positive (all were higher than 3).

The survey results for the mobile clicker context (Situation 2) were quite similar to those found in the traditional clicker situation. The most prominent advantage of mobile clickers was in helping students to identify their misunderstandings. Of the seven questions on the theme of ‘understanding’, four (Q5, Q8, Q11 and Q10) had scores above 4 (4.26, 4.22, 4.08 and 4.05, respectively). There were three questions (Q1, Q3 and Q4) in the ‘processes’ theme with scores higher than or at 4 (4.18, 4.16 and 4.00, respectively). The students were generally interested in using the system, and indicated they would like to use it in other courses, or would recommend using it again for future courses. Questions Q14, Q15, Q12, Q17 and Q13 in the ‘overall comments’ and ‘attitudes’ themes had scores of 4.21, 4.14, 4.07, 4.06 and 4.00, respectively. As in the surveys of students in Situation 1, the questions related to ease of use were also rated lowest but still scored higher than 3.

### 3.2 Difficulties in using the traditional clickers and other comments

All of the data concerning Situation 1 came from open-ended questions (there were no such questions in the Situation 2 survey). The Situation 1 students were asked if they i) had any difficulties in using the clicker, ii) had any suggestions for improving clicker use, iii) whether they wanted the clicker to be used for anything else and iv) if they had any other comments. The overall results seemed to be quite positive, because the number of difficulties that the students encountered was not very high. Even when they were asked to suggest improvements, some of them gave compliments instead.

For point i) (any difficulties), the response rate was low (only seven), and the answers were brief. These responses were mainly concerned with the details of use during the process, such as not enough time for answering questions or difficulty operating the clicker if it was placed too far from the receiver.

For point ii) (suggestions for improvements), there were 16 responses. Some of these were actually compliments concerning the use of clickers. Five of the responses were non-critical, such as ‘perfect already’, ‘lecturer can know what topic needs further elaboration’ or ‘more of this kind’. Another eight responses concerned how the lecturer could use the system better, with suggestions such as ‘the questions should not be too long or complicated’, ‘better to show the overall performance for each individual clicker’ or ‘inform students of the use of clickers in the next lesson to allow better preparation’.

For point iii) (whether clickers should be used for anything else) there were 20 responses. Most of these seemed to be positive regarding the use of clickers in other areas. Half of the responses were suggestions that clickers could also be used in course evaluation and voting while the others indicated a desire for broader use in general (with comments such as ‘use it more frequently’, ‘other topics of the course’ and ‘other lessons’).
Only one of the responses seemed conservative: ‘Please use clickers only for question practice. It is not useful (in my opinion) for an overall review which we were expecting’.

For point iv) (any other comments), there were eight responses, most of which were positive, such as ‘I love clickers’, ‘should use clickers frequently’ or ‘more clicker questions’.

3.3 Preferences

As the students who used the mobile clickers also had previous experience using the traditional clickers, they were asked about which type of clicker they liked best and why. All of the data concerning these preferences were collected from the classes in Situation 2.

In this portion of the survey, we found a distinct preference, with the majority of the participating students favouring the traditional clickers, although for somewhat differing reasons. Of the 114 students in the Situation 2 classes who answered the preference question, 99 selected the traditional clicker as their preferred type.

The most frequently mentioned reason for this preference (22 responses) was that not every student owned a mobile phone that could connect to the Internet. In addition, 19 students thought that the traditional clicker was easier or more convenient to use. There were several additional reasons given with a lower frequency, but which also seemed important. These concerns included the long time that it could take to connect to the Internet (10 responses), difficulties in connecting to the Internet (10 responses), the consumption of mobile phone battery power in accessing the Internet (3 responses), the limited quotas of campus WiFi logins (2 responses), the small screens on phones (2 responses) and other technical problems with using mobile phones (2 responses).

Only 15 students selected mobile phones or both mobile phones and traditional clickers as their preferred type of response system, and many did not give a reason for their choice.

4. Discussion

The findings for Situation 1 were generally positive and seemed to affirm similar findings from previous studies. The use of traditional clickers was first introduced into biomedical physiology courses in 2009 as a pilot e-learning project organised by the School of Biomedical Sciences of the Faculty of Medicine. The majority of students at that time had never been exposed to this e-learning tool in previous courses. In fact, the use of any kind of student response system was relatively uncommon at that time, primarily because most teachers were not yet aware of the student response systems offered by software and hardware companies.

When the traditional clickers were given to the students the first time, most of them were excited about using the small hand-held devices in class. Clickers certainly showed a magical power to retain students’ attention, as Fifer found in a later study (2012).

In terms of learning benefits, the performances of traditional and mobile clickers did not seem to vary a great deal. Surveys of students taking the five courses showed that the clickers were generally well received and viewed as beneficial. Also, by and large these benefits correspond well with those commonly suggested in the literature:

- Comprehension – using clickers helped improve students’ comprehension of lecture content (Vana et al. 2011; Oigara & Keengwe 2013). Related comments were reflected by Q5–Q11 in our survey. A common response that we obtained from these students was that the use of clickers at the end of class helped them reinforce and clarify difficult concepts concerning the bio-molecular and bio-chemical mechanisms of human physiology. In response to such positive feedback and to frequent requests from the students, in 2010 the school officially incorporated the use of clickers into five physiology courses: four at the undergraduate and one at the Master’s level. As in Voelkel and Bennett (2013), our survey showed that students perceived clickers to be a valuable tool for reinforcing concepts and identifying misunderstandings.

- Enjoyment and motivation – Fifer (2012) remarked that clicker activities can be enjoyable and improve students’ concentration. Our findings (such as the comments collected from Q4 and Q12–Q13) generally confirmed this, whether students were using traditional or Web-based clickers.
Interaction – many researchers, such as Tremblay (2010), Voelkel & Bennett (2013) and Armesen et al. (2013) commented on the increased classroom interactions made possible by the technology. This phenomenon was also present in our study (refer to Q1–Q3).

This study did not, however, confirm that the mobile clickers were more convenient, at least from the students’ perspective. Most of the participants surveyed showed a distinct preference for using traditional clickers. Those who replied to the survey indicated that traditional clickers were more user-friendly and convenient.

The challenges were of many types. There were problems with the capacity to connect to the Internet. Some of the participants reported poor Internet connections, which reduced their interest in using mobile clickers. Even though WiFi is supposed to be available in this all-campus environment, some students commented that it was not strong enough for all of the students in the classroom to go online at the same time.

Another problem was that connecting to the Internet for the mobile clicker sessions tended to use up students’ phone batteries. Some students did not own the right kind of device for mobile learning. Students from the Situation 2 classes immediately commented that it took them too long to log into the mobile software system, and some reported experiencing technical problems with their mobile devices.

The software we used also created challenges. In addition to the student survey responses, the teachers pointed out other drawbacks in using a Web-based clicker system; namely, the limitations of class size and the need to purchase a licence to use the system. As the licence has to be renewed every year, this would probably impose a financial burden on some teachers. The technology used in our study was relatively expensive and had certain technical limitations. The online licences were purchased based on the number of concurrent student users. At the time of our study, we purchased 20 such licenses – a number we found to be insufficient, as there were clearly more students who had mobile devices in the classes. As a result, some students spent significant amounts of time trying and failing to log in. At that time, the system server was located overseas, which was another limitation of the technology. The classroom interactions involved long-distance online traffic from Hong Kong to and from the server in Australia, which caused the system responses to be slower, especially compared with the experience of using the traditional clicker system.

Despite the challenges, the Web-based solution has certain advantages over the traditional clickers. For large-sized classes such as those for nursing students, in which the normal class size is about 200, it was a physical burden for teachers to bring the clickers and distribute them to all of the students. This inconvenience was also mentioned by Jones, Marsden and Gruijters (2006). Collection of the clickers after class also required patience from both teachers and students. In many cases, the teachers found it necessary to assign class representatives to ensure the timely distribution of clickers amongst students.

5. Conclusion

Overall, our student surveys reported the beneficial effects of clickers in terms of student learning, but also identified a number of limiting factors in using Web-based clicker systems. Some of these issues were encountered in the previous study at our university, such as the problem of not every student owning a compatible mobile device (Lam et al. 2011). Other issues were exposed by this study (e.g., poor connections and consumption of battery power). We believe that this situation can be improved as better technology becomes available. Teachers can also benefit from the additional features of clickers. For example, the use of response systems can help teachers to revisit student responses for assessment, course design and development. However, the significance of clickers in both teaching and learning enhancement is not yet acknowledged by most teachers. There is still poor teacher participation in the use of both traditional and mobile clickers, as reflected by the relatively low percentage of clicker use in other courses.

Although we did not find overwhelming advantages of Web-based clickers over traditional clickers in this study, we remain optimistic about the future of Web-based solutions. Internet connectivity in classrooms will continue to improve, and students' ownership of suitable mobile devices is likely to experience significant changes in the years to come. Thus, student response systems should continue to evolve in terms of user-friendliness and affordability.
Acknowledgements

This project would not have been possible without funding support from the School of Biomedical Sciences of the Faculty of Medicine, which allocated a special internal grant for the purchase of 200 traditional clickers for teaching and learning enhancement.

References


www.ejel.org 356 ISSN 1479-4403
Virtual Reality Based Behavioural Learning For Autistic Children

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Abstract: Autism is a disorder in the growth and development of a brain or central nervous system that covers a large spectrum of impairment, symptoms and skills. The children who are suffering from autism face difficulties in communicating and adapting well in the community as they have trouble in understanding what others think and feel. Therefore, there is a need to design effective e-learning method to ease the communication process and to deliver required knowledge to autistic children. Past researchers have highlighted that a virtual reality based learning environment, a computer simulated environment, can facilitate the learning process among autistic children. It is also recognized that the virtual agent plays an important role in virtual worlds as it eases the communication process between the virtual environment (VE) and children with autism. This research aimed to design an effective learning environment for autistic children by developing a virtual environment prototype using face-to-face interviews and picture exchange communication system (PECS) methodology for data collection which was analysed using quantitative tests. The findings suggest that the toilet virtual environment topped the list for being the most popular learning environment among autistic children for behavioural training. The designed prototype identifies autistic children’s and their parents’ needs and also addresses limitations in an existing virtual environment.

Keywords: autism, picture exchange communication system (PECS); virtual environment (VE); virtual agent

1. Introduction

Virtual reality enables e-learners to visualise the learning process, manipulate findings with relative complex sets of data and interact with current technologies (Kadir & Xu, 2011). The visualization process refers to visual representation in computers, auditory components or any other forms of sensory outputs displayed in a virtual world. According to Abdul-Kader (2008), the virtual reality can be classified into three categories; desktop virtual reality, fish tank virtual reality and immersive virtual reality. Additionally, he concluded that applications of virtual reality have the potential of developing into a wider spectrum, which can diverge from entertainment purposes to educational purposes. On the other hand, the most recent application of virtual reality is the interface to e-learning applications, which is also known as virtual reality based e-learning tool. The potential of virtual reality tool is demonstrated by its ability to facilitate learning processes while avoiding many problems characterizing traditional or conventional teaching learning methods.

A multitude of e-learning educational systems that were developed recently incorporates virtual environments. Most of the medical and scientific subjects are the leading e-learning applications that use virtual reality technology (Dimitropoulos et al., 2007; Huang et al., 2010; Albeau, 2008). With this in mind, many virtual classrooms are set up to facilitate virtual learning in educational institutions and training centres. It is also noted that over the years, advancement in the virtual reality technology has opened up numerous application possibilities such as providing guidance for disabled children (Albeau, 2008; Reid, 2011; Kandalaft et al., 2013). Therefore, in a hope of broadening the studies that have already been done, this research focused on enhancing and facilitating the learning process of the specified target group of autistic children.

Several countries abroad have been implementing caretaking service centres and nurseries to assimilate an education for these children with special needs. In Malaysia, the government has taken the initiative to set up centres such as Fakih Intellect Academy, Cads Enhancement Centre, Kidzgrow and Chatterkidz Therapy to assist autistic children’s parents and caretakers to educate the autistic children effectively. Most of the
children in these facilities suffer from poor social interaction, lack of communication skills, and portray unusual and distinguishing behaviours similar to the scenario elaborated by Zander (2004). On account of such issues, some specifically designed teaching methods have been made available to allow autistic children to learn better, for example; applied behavioural analysis (ABA), treatment and education of autism and related communication handicapped children (TEACCH), floortime, social story, and picture exchange communication system (PECS) etc. (Selpa & Marin, 2001).

Despite of all the possible advantages of implementing virtual reality based tools the teaching methods stated above still possess various disadvantages. These disadvantages could include any of the following: requiring special guidance, skills domination, imagination problems, equipment storage and deterioration of storage medium (Selpa & Marin, 2001). However, most researchers have considered virtual reality based learning tool to be an effective tool for autistic children to facilitate the teaching learning process (Albeanu, 2008; Reid, 2011; Kandalaft et al., 2013). To add on, VE provides great potential for people with autism because users can play a role in an environment designed to imitate definite social situations. The increasing sophistication of VEs means that skills and tasks can be practiced in realistic settings. This has been identified as an approach that gives encouraging support to enhance the children’s social skills (Strickland et al., 1996).

Autism is a spectrum of closely-related disorders with a shared core of symptoms. Every individual on the autism spectrum has problems to some degree with social skills, empathy, communication, and flexible behaviour (Mesibov et al., 2000; Happé & Frith, 1996). Due to this, to educate autistic children on social skills, a flexible and interactive teaching method or technique should be established. This learning style must be an enjoyable learning process that allows them to gain more and experience the real scenario via the implemented system. However, the majority of the prevalent methods of teaching aids available to autistic children have certain drawbacks in terms of enhancing social skills. Alternatively, there are many applications available online to serve this purpose, but it might be time-consuming due to the time required to download such applications. Additionally, it might also require more digital storage space depending on the size of an application in certain mobile devices. In Malaysia, mobile technology is an emerging technology and is gaining wide popularity. However, this technology is not owned by the majority and therefore there is some limitation to the access of smart phone applications that cater to needs of autistic children. It has been observed that many parents do not own smart phone technology to provide behavioural training to their autistic children via virtual reality based behavioural training and learning resources due to the high cost.

Several online applications also demand the user to spend more time in constructing a social story, whereby, the user is required to create a virtual environment for a specific behavioural training. Apart from that, it is not an easy task to obtain a suitable graphic to be used as a teaching and learning material for autistic children. However, it is important to use effective graphics in the virtual environment as it is a more appealing tool for teaching these children. Hence, pictures used should be realistic and cater to educational needs (Simon et al., 1986). The research aimed to create a virtual environment for autistic children that includes a virtual agent which can role play to educate autistic children on ‘how to behave’ at specific places or scenarios. Aligned with this, the derived objectives of this research are as follows:

- To identify the virtual environment (VE) needed for the behavioural learning process of autistic children;
- To ascertain the virtual environment (VE) requirements to educate autistic children; and
- To evaluate the prototype for virtual reality based learning application which includes virtual agents.

2. Literature Review

Autism is comprised of severe enveloping impairments in several important areas of development in a person. These impairments could be any of the following examples; social interactions, communication, behavioural, and imaginative (Happé & Frith, 1996; Wing & Gould, 1979; Wing, 1998). The majority of autistic children encounter learning difficulties, even though some might have been equipped with an average intelligence (Sallows & Graupner, 2005; Pinker, 1999). The disability of these children can also fall under the categories of epilepsy, visual and auditory problems. Autism is related to the behaviour of a person as an effect of unknown biological dysfunctions of the brain that has consequence on the development or reaction of the brain while handling information. This dysfunction can range from issues that lie between any of the received information, processed information or even interpreted information (Mesibov et al., 2000).
Autistic children mostly suffer from poor social interaction, communication, behaviour, and large variations in learning abilities (Zander, 2004). In the article entitled “Intro duktion om autism”, Zander (2004) asserted that social interaction is a main issue encountered by autistic children, whereby the children have difficulties in conducting eye contact, body language, facial expression, and modulation (Church et al., 2000). Many autistic children are unable to show social or emotional feedback and do not share their feelings with others (Ozonoff, & Cathcart, 1998). It is also noted that autistic children do not share similar interests as other children of the same age. Even if they do, they are unable to express themselves well and develop and maintain friendships. Autistic children are naturally delayed in language development (American Psychiatric Association, 2000). Hence, most of these autistic children develop poor speaking skills as it is a difficult task to promote social and communication skills in children with autism (Zander, 2004). Besides this, they also exhibit unusual, distinguishing behaviour which includes limited interest and concerned on a specific object, hard adherence, and flexible observance to non-functional regularity. Zander (2004) also highlighted examples of such distinguishing behaviours such as spinning the wheel of a toy, lining up toys repetitively, yet seldom engage themselves spontaneously and picking up different games and role plays.

Besides this, Zander (2004) also concluded that the level of seriousness in autistic children varies from one individual to another in terms of intelligence and learning ability. This might be due to several causes such as depression, the nature of the autism disorder, epilepsy, genetic symptoms, etc. Hence, the need to develop an attractive and an effective method to teach these children arises. There are several effective teaching methods identified to be used while educating these autistic children. Table 1 below shows several popular teaching methods for these special children.

<table>
<thead>
<tr>
<th>Teaching Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Behavioural (ABA)</td>
<td>Learning method by using an alphabetical model in order for them to be more focussed, responsive and imitate (Birnbrauer &amp; Leach, 1993; Sallows &amp; Graupner, 2005).</td>
</tr>
<tr>
<td>Treatment and Education of Autism and Related Communication Handicapped Children (TEACCH)</td>
<td>A type of teaching method that is more structured and can be applied at home and classroom as well (Mesibov, Shea, &amp; Schopler, 2005). This method focusses on the changing environment which suits children according to their needs. However, this technique requires the parents’ active participation (Ozonoff &amp; Cathcart, 1998).</td>
</tr>
<tr>
<td>Floortime</td>
<td>A method whereby the trainer enters the children’s world and looks at things from their perspective to provide help to expand their thoughts and ideas (Greenspan &amp; Wieder, 1997). The highlight of this method is its ability to incorporate two-way communication skills, expression, ideas and feelings within its educational purposes (Selpa &amp; Marin, 2001).</td>
</tr>
<tr>
<td>PECS (Picture Exchange Communication System)</td>
<td>Parents and caretakers are required to participate in an intensive training on how to use binders and picture cards as it comprises of 6 phases which can be considered as rather time consuming (Bondy &amp; Frost, 1994). Furthermore, this meta-analysis analyses the extant empirical literature for PECS relative to the targeted (functional communication) and the non-targeted concomitant outcomes (behaviour, social skills, and speech) for learners with autism, learners with autism and intellectual disabilities, and those with autism and multiple disabilities (Ganz et al., 2012).</td>
</tr>
<tr>
<td>Social Story</td>
<td>Social Story was developed by Carol Gray which began in 1993; it was used to teach disabled children by providing accurate information in challenging situations (Reynhout et al., 2008). Social Story also provides guidance by describing the patterns on performing an action in sequence.</td>
</tr>
</tbody>
</table>

Table 1: Teaching Methods for Autism Students

A virtual reality based learning tool that includes a virtual environment (VE) and virtual agents is an effective method to support the social communication skills of children with autism. In such conditions, where social skills can be practiced repeatedly, the result possess a less threatening, less social challenging, more
controllable and comfortable process when compared to a face-to-face communication scenario (Rajendran & Mitchell, 2006). Besides this, it also allows the user to truly see on the screen rather than how the environment is actually encountered in real life. For example, the user would experience this via a standard personal computer and headsets (Parsons et al., 2004). It is also noted that the popularity of virtual agent technology is due to its support to component based software engineering, flexible operations, easy software maintainability, adaptability to the real world and an extensibility of the software itself. Virtual agents have become increasingly prevalent in human computer interaction (HCI). Among the examples are embodied conversational agents and avatars. Embodied agents can be defined as ‘Interfaces based on the anthropomorphic metaphors, which look human-like and mimic a face-to-face interaction style.’ Examples of various embodied agents used in HCI research are embodied conversational agents (ECA’s), relational agents (RA’s), pedagogical agents (PA’s) and chat-bot agents (Ramachandiran & Jomhari, 2014). The ECA’s are synthetic characters that can maintain a conversation with a user. Hence, many virtual-reality based learning tools use virtual agents to deliver knowledge and skills to autistic children.

Virtual environments also include the representation of people or virtual agents and objects which have been used in various fields for cognitive treatment (Sarah et al., 2004). For example VE has been used in overcoming dizziness among autistic children and pteromerhanophobia of some patients (Rothbaum & Hodges, 1999; Chorpita, 2014). VE has also been used in helping disabled people develop everyday skills (Brown et al., 1999). According to Parsons et al. (2004), VE is one of the tools which can be used in teaching a social story for autistic children. Past research also highlights an individual case study conducted to produce a report based on an observation and comments from two autistic children using two different virtual environments such as virtual cafe and virtual bus environment (Parsons et al., 2006).

3. Research Methods

This research used a mixed methodology comprising both qualitative and quantitative analysis. The qualitative method focuses on an interview and an observation survey. The interview was conducted as part of the preliminary study for this research. Besides conducting interviews, the student observation was also carried out during this face to face interaction session. The quantitative method was then used to analyse findings of this research that uses the PECS teaching method for autistic children (Bondy & Frost, 1994). It is clear that PECS is a communication method that does not require speech and has been widely used in various researches pertaining to autistic children. It is based on an exchange of a picture of a real object by finding and reaching for someone’s assistance to deliver the message effectively. With that exchange, the children themselves start the act of communication. Thus, the main objectives of using PECS set by the researchers are that the child initiates the communication, finds and approaches a communicative partner and uses only one picture in order to avoid a confusion about what he or she wants (Bondy & Frost, 2002). Not only disabled children, but normal children can also use PECS to communicate and deliver messages effectively. The research is divided into four phases as depicted in Figure 1.

![Four Phases Diagram]

Figure 1: Four Phases

The data collection process is one of the most important tasks in any research project. An incorrect or an inaccurate data collection may affect research findings. The data collection can be divided into quantitative method and qualitative method. Interviews and questionnaires are categorized under the quantitative method, whereas, the in-depth interview, observation methods and document review are categorized under the qualitative method. In this research, face-to-face interviews with parents were conducted to gather information on the essential needs and VE design criteria for their children. Phase 1 is the preliminary research
phase, in which the respondents were interviewed. The respondents identified for this research are the parents of autistic children. A total of 41 parents participated in this phase of research. The objective of this phase was to identify the virtual environment required for learning. This was conducted in an autistic learning centre, Fakih Intellect Academy located in Malaysia and in the presence of 41 autistic children. The selection criteria of the environment were divided into two classifications, which was the indoor and outdoor. In the indoor criteria, the researcher selected the bedroom, toilet, kitchen, living room, and dining room. Alternatively, for the outdoor criteria, the environments selected included classroom, shopping mall, hospital, bus, and café.

Once the virtual environment design criterion is defined, the PECS methodology was used to select the best fit specimens or objects related to the chosen environment. One of the main reasons why PECS was used is because the picture exchange communication system (PECS) is a widely accepted picture or icon aided augmentative communication system designed for learners with autism and other developmental disorders (Bondy & Frost, 1994; Ganz et al., 2012). Figure 2 depicts the specimens used in the Phase 2 of this research. All objects/specimens are related to the toilet virtual environment, as it is the outcome of the preliminary study in Phase 1.

Figure 2: Research Specimen
On the other hand, Phase 3 focuses on the prototype design using all the selected specimens from Phase 2 by the 41 respondents. Next, Phase 4 validates the prototype finalised during the Phase 3. During this phase, the prototype for the toilet virtual environment is viewed and validated by the respondents. An interview was conducted to gain information to enhance the prototype design and to validate the design. The role of virtual agents was also identified in this phase of research.

3.1 Respondents
Respondents for this research are both parents and autistic children. Face-to-face interviews were conducted to gather required information. During the preliminary study, an interview was conducted with 41 respondents. Then, an online questionnaire was distributed among the same group of people aged from 20 – 50 years. To conclude, a total of 41 parents have participated in this research from which, 31 of the sample respondents were female (76%) and the other 10 were male (24%). The respondents are from the various ethnic groups, 15 were Malay, 7 Chinese and 19 Indian. For autistic children respondents, 29 respondents (71%) are male and 12 respondents (29%) are female.

4. Analyses and Results
In the preliminary study, the environments were categorised into 2 categories of indoor and outdoor. Several types of environments were listed in the indoor categorization such as the bedroom, toilet, kitchen, living
room, and dining room. From the listed environments, the most preferred environment ‘toilet’ scored a significant 66%, making it the most requested training options. As for outdoor environments, the listed types of environments are the classroom, shopping mall, hospital, bus, and café. From the entire scenario, the classroom environment was selected by 46% of the parents as outdoor environment training requirement. Alternatively, the indoor environment toilet was selected by most respondents. Table 2 summarizes the findings in relation to respondent’s virtual environment preference.

<table>
<thead>
<tr>
<th>Environment Types</th>
<th>Percentage (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedroom</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Toilet</td>
<td>66</td>
<td>54.28%</td>
</tr>
<tr>
<td>Kitchen</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Living room</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Dining Room</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Outdoor</td>
<td>45.82%</td>
<td></td>
</tr>
<tr>
<td>Classroom</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Shopping Mall</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Café</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Respondents Virtual Environment Preference.

From the findings of Phase 1 of the research, the prototype design, implementation, and testing were carried out. In this case, the toilet VE (Indoor) was designed. A few types of the toilet, tap, flush, and washbasin were selected and presented to parents. Among the specimens, the highly rated specimens are depicted in Table 3. Table 3 summarizes the outcome from Phase 1 showing the preference and the percentage of votes for the toilet VE.

<table>
<thead>
<tr>
<th>Toilet object / specimen criteria</th>
<th>Highest vote using pecs (%)</th>
<th>Other votes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet Design</td>
<td>Specimen 1 (85%)</td>
<td>Others (15%)</td>
</tr>
<tr>
<td>Flushing System</td>
<td>Specimen 5 (80%)</td>
<td>Others (20%)</td>
</tr>
<tr>
<td>Wash basin</td>
<td>Specimen 9 (100%)</td>
<td>Others (0%)</td>
</tr>
<tr>
<td>Tap</td>
<td>Specimen 13 (60%)</td>
<td>Others (40%)</td>
</tr>
<tr>
<td>Virtual Agents</td>
<td>Specimen 16 (40%)</td>
<td>Others (60%)</td>
</tr>
</tbody>
</table>

Table 3: Toilet VE Specimen Preference

A total of 41 parents and 41 autistic children participated in the testing phase. The role of the parents in this phase that uses the PECS methodology was to facilitate children to communicate and choose the specimens. Based on an outcome, the parents who participated preferred the sitting type toilet design (Specimen 1)
compared to the other specimens in the same category. From this finding, we can conclude that 35 parents (85%) preferred sitting toilet (Specimen 1) and the remaining 6 respondents (15%) voted for other specimens from the same category.

However, the height of the sitting toilet remains a major concern for parents as a minority of autistic children suffer from acrophobia, which is the fear of height. The finding supports the evidence of previous research examining the types and frequencies of fears in children with autism where the findings show odd and intense fears in approximately 40% of children (Chorpita, 2014). To elaborate further, squat toilets are not popular among parents due to hygiene concerns. It is also noted that some children have the habit of fiddling with objects around the toilet and therefore several safety precautions must be taken.

Based on the interview, most parents preferred tap (Specimen 13) due to ease of use. On the other hand, flushing system (Specimen 5) was rated the most popular as it is easy to operate and children with autistic disorder can adapt to this product design faster and for the wash basin category specimen 9 topped the list.

Virtual Agents (Specimen 16) gained wide popularity as 70% of the autistic children are Male and the respondents believed that it is more practical and makes the virtual world seem real to design a prototype with a male agent. A total of 16 respondents opted for this virtual agent and is very popular among autistic children.

5. Discussion and Conclusion

There is an increasing recognition that successful learning requires not just quality instructional content, but also an appropriate context that includes facilitation and an understanding of the e-learner. In this case, autistic children need an effective learning tool not only to develop their knowledge, but also their behaviours. It is noted that due to the autism disorder, these children develop unusual fears which limit their ability to carry out their daily chores (Zander, 2004; Sheinkopf et al., 1998). Though, there is a wide domain of virtual reality based learning tools that are available today, but only a few selections of tools are useful for autistic children. Therefore, virtual reality based environment for educating autistic children must be given serious consideration as these tools can assist in the learning process and minimise their level of fear. This is similar to the findings from the research conducted by Selpa and Marin (2001).

In this research, a prototype of the toilet virtual environment with a virtual agent was designed for behavioural learning among autistic children. The fact still remains that any virtual environment application should be created based on a prototype that has been developed and tested repeatedly. The research should include a wider group of different parents of both normal and disabled children. Figure 3 below depicts the proposed toilet VE for autistic children. This proposed virtual environment was created based on research findings and can be implemented to guide autistic children in behavioural training.

**Figure 3: Virtual Toilet (view from three different perspectives)**

Apart from the selected objects or specimens used in the proposed virtual environment, there are other concerns highlighted by parents. Among the additional specimens requested by them are mirrors, bathroom mat, tissue, towel, air freshener, and plants. Other equipment requested for include ventilation, soap holder, towel holder, tissue holder and dust bin. Some respondents requested for more unique toilet VE items such as a small hand towel to cover a Muslim child’s head, shelves and decorative items for a cosy environment. Additionally, this design incorporates the various specimens from the PECS data collection and also cultural aspects. While Malaysia is a multiracial country having many cultural barriers, this design managed to
harmonise cultural differences and the virtual environment is well accepted by respondents from various ethnicities in Malaysia such as Malay, Indian and Chinese. Figure 3 depicts the proposed prototype design.

While designing the prototype, the researchers took into consideration that different autistic children have different capabilities. Some disabled children might be more aggressive or physically weaker than normal children. Therefore, all the specimens used in this prototype design are easy to use and less complicated.

Another interesting finding from this study is that the age of parents does play an important role in the teaching process of autistic children as younger parents are more afraid in handling children and seem very depressed with the condition of their children where older parents are more confident and understand the nature of autism. Sufficient training must be provided to parents to educate them on the nature of the disease and as it can affect the mental growth of children since parents are their role models and facilitators.

Although this study has provided valuable insights, it has some limitations that can be addressed through adopting a larger sample. With advancement in technology, future research on virtual reality based learning can be used to address the unusual fears among autistic children such as mechanical things, heights, weather, places, and visual effects as discussed by Chorpita (2014).

Acknowledgement

This study is funded by Taylor’s Emerging Researchers Fund Scheme (ERFS/1/2013/ADP/002), Taylor’s University, Malaysia.

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Visualizing Solutions: Apps as Cognitive Stepping-Stones in the Learning Process

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Abstract: In many K-12 and higher education contexts, the use of smart mobile devices increasingly affords learning experiences that are situated, authentic and connected. While earlier reviews of mobile technology may have led to criticism of these devices as being largely for consumption, many current uses emphasize creativity and productivity, with diverse purposes ranging from blogging and social networking to near full-scale video editing, office productivity and language translation. These affordances are further made possible by the large-scale development of mobile applications (or apps). For the vast majority of mobile device users - now numbering in the billions – many of these learning experiences are informal and just-in-time, sometimes unplanned, unsanctioned by educational discourse and beyond the immediate locus of institutional control. As smart technologies become increasingly an extension of the personal, educators are faced with the question: how can we best facilitate and explicate the learning process and design relevant experiences that leverage the affordances of so many mobile devices? This paper explores how the effective use of apps enable the learning process to be visualized in ways that support meaningful and student-centered learning. The authors discuss recent developments in technology, mobile learning and multiliteracies, drawing on a range of case studies deploying mobile devices and using apps as part of learner-led inquiry processes to enable creativity, collaboration and critical thinking. Emerging from these case studies are real classroom examples, teacher-student reflections, scaffolds and working models that all speak to the importance of using apps to visualize learning and support learners at each stage of the learning process. Exploring the connections between mobile devices, media literacy and visual literacy, the paper also emphasizes the collaborative affordances of many current apps and the importance of multimodal forms of representation through gesture, voice, text, video and audio. Citing the common issues involved in deploying mobile devices in most education institutions, the authors argue the need for schools and education systems to move away from infrastructure-led developments towards more learner-led solutions.

Keywords: apps, m-learning, tablets, smartphones, inquiry

1. Introduction

Recent sales forecast data illustrate the rapid growth of mobile devices around the world (IDC, 2014). While these figures show an exponential increase in the number of smartphones and tablets sold, sales of desktop and laptop (portable) computers show little growth in the short-to-mid term and decline in the long term. Sales of mobile devices – and especially tablets – will continue to further challenge traditional forms of computation. In particular, as the number of technology devices and tools escalates, there is now a growing emphasis on the personalization of technology for the individual. Increasingly, users are able to tailor mobile devices to suit their needs through ubiquitous access to Internet connectivity and the use of personalized apps on what are, essentially, very personal computers. As more people explore mobile devices as tools for productivity, creativity, collaboration and sharing, the affordances of these devices will continue to adapt to users’ needs and interests. A recent example is the development of full-featured office suites for the iPad. As an established device, the iPad now represents a whole ecosystem, having been regarded as the “first of a new class of devices that is now being used in educational settings” (Reid & Ostashewski, 2011, p. 1661). As a term, “ecosystem” implies that there is a broader architecture surrounding the device and established relationships between the software, hardware and services underpinned by common platforms, operating through the exchange of information and system resources (Messerschmitt & Szyperski, 2003). Examining the device and its ecosystem, earlier criticisms of the iPad tended to label it as a tool for “consumption” (Rodrigues, 2011), reflecting broader concerns that mobile devices represent “appliances” rather than full-featured computers (Zittrain, 2009). However, with office productivity suites like Microsoft Office, Google Docs, and iWork now available, users are choosing to employ iPads for office productivity (amongst many other uses), supplanting the need for a traditional desktop or laptop computer and, to an extent, redefining the capabilities of tablet devices. Competition from other platforms such as Microsoft’s Surface Pro Tablet – with a full-featured Windows operating system – means that affordances on all tablet devices are likely to expand as a result of

market pressure, growing user bases, competition and consumer needs, and that at least part of this expansion will involve supplanting traditional computing devices.

2. New Times, New Literacies

In their comprehensive review of the literature, Rossing, Miller, Cecil and Stamper (2012) define mobile learning (often referred to as m-learning) as “the efficient and effective use of wireless and digital devices and technologies to enhance learners’ individual outcomes during participation in learning activities” (p. 2). It could be argued that this definition only begins to explain these tools, with their mobile and portable nature being key to these devices. In many contexts, mobile learning has been on the horizon for some years (Johnson, Levine, Smith, & Smythe, 2009). During this time, a number of educational jurisdictions have been exploring the use of mobile devices – especially tablets – in the classroom. In some cases, this involves the trial use of a small number of devices by interested teachers. Elsewhere, students purchase their own mobile device and bring it to the classroom in schools where the infrastructure allows the device to be used (“bring your own device,” or BYOD), while other schools mandate the use of a particular device that is deployed as part of many 1-1 (one device for every one student) programs. While technology programs that scale the specific use of devices are not new, the advent of mobile hardware - with often-superior battery life, lightweight and portable - has seen fresh impetus to the broader use of technology in many schooling systems. These developments have seen an increase in the number of school programs where mobile devices are deployed or brought to the classroom.

At the same time, as more mobile devices are used in classroom settings, the need to think beyond traditional print-based literacies is increasingly reflected in school curricula, teacher pedagogies and educational research. Learners now have a wider range of options for interacting with digital content, and the visual nature of many mobile apps and interfaces is playing a key role in extending the range of literacies being explored. For example, apps support newer forms of content creation such as “mashups,” where learners respond to multimedia by creating new texts that include segments of images, audio and video that represent new meanings through the layering of this digital material. Most apps are internet-enabled and allow content to be shared, co-authored and published. Websites like Creative Commons encourage open engagement with visual content, providing stimulus and inspiration to learners when interacting with content and each other. Rather than the traditional keyboard and mouse interfaces – oriented around text and simple graphical user interfaces – mobile devices enable gestural and voice control, with most devices including video cameras for capturing and sharing content in real time.

While the body of research that exists in relation to largely pre-Internet visual media still holds relevance, there is a need to update current thinking on the relationship between technology, media literacies and visual literacies. For example, earlier research in visual literacy has explored the extent to which, “reality itself is mediated by visual images,” including the role of the associations the viewer brings to the visual text, how they are positioned by the composer and the importance of visual intertextuality (Stephens, 1998, p. 165). At the same time, earlier discussions of visual literacy that pertain to pre-Internet text types – such as magazine images, billboard advertisements and photo scrapbooks – underscore the limitations of the composer-viewer relationship with these static, older forms of media. In these earlier visual media, viewers are often automatically positioned as passive consumers of content. Most of these forms of media are largely or solely “one-way” in terms of content being conveyed from the composer to the responder on technology tools such as the television and radio. The viewer’s “response” to visual texts within this paradigm often involves analytical and meta-analytical discourses, but not always learner engagement with the tools of production available to the composer of the original text. However, with recent technologies, learners are part of the same paradigm, having access to low cost devices capable of near-professional production.

When thinking about this paradigm shift in terms of literacies, some have argued that new media literacies are much more about discourse-based actions than skills. Lankshear and Knobel (2006) define literacies within the new media paradigm as “socially recognized ways of generating, communicating and negotiating meaningful content through the medium of encoded texts within contexts of participation in Discourses (or, as members of Discourses)” (p. 64). Citing the impact of Web 2.0 with a growing number of web applications that support creativity and sharing, they argue that the digital age encourages literacies as forms of doing and being. When learners engage with these forms, they extend the range and nature of literacies that exist. In this context, learners play a vital role in mediating an increasingly visual reality through the use of technology tools that
enable newer interfaces. As Mallia (2013) states with respect to the important relationship between visual literacy and the use of technology tools:

> Although visual perception seems to precede any textual explanation, the combination of images, media and new technologies will require students to be multiliterate. This new literacy will fuse visual literacy with innovative forms of technology and digital communications. As we are in the beginning of a new millennium, it is evident multimedia visual literacy is essential to our culture, wherein visual technology is connected to the communication needs of the current generation (p. 369).

In summary, mobile devices are encouraging a much wider range of literacies as forms of doing and being in a digital age. Rather than being the passive consumers of the pre-Internet age, learners are now able to employ the tools of professional composition to create, co-author and publish visual texts to reflect their world. As highly personal, portable connected, mobile devices play an integral role in shaping these emerging forms of literacy.

3. Schools and Smart Mobile Devices – Exploring the Evidence

Given the possibilities, it is important to consider the evidence supporting the use of smart mobile devices in schools. Some researchers have tended to raise more concerns and questions than clearly identified positive outcomes. For example, in a study of high school and primary students’ use of iPods and iPads in a school where these devices were deployed in two phases, Crichton, Pegler and White (2012) found that when given the choice between using tablets and laptops, students only preferred tablets “for a variety of commonplace tasks,” while preferring laptops for “for searching the Internet, creating media, and checking email.” This study also found that in relation to iPad use in the classroom, “high school students and teachers were more critical [than primary students], as both appeared to struggle to find educational uses for the devices” (p. 23). In another comparative study, Culén and Gasparini (2011) found similar resistance among both high school and tertiary students, reflecting the perceptions of the iPad as not an effective “platform for work purposes” (p. 200). Drawing attention to the considerable differences between iPad affordances and those of traditional (and still common) computer labs, Khaddage and Zeidan (2012) question whether most higher education institutions are ready for tablet devices as learning tools.

However, other findings for a range of education contexts have been more encouraging. For example, in a study of 1-to-1 iPad deployment in one high school, Foote (2012) found that the deployment itself fostered “an exploratory climate on campus—as teachers, students, and administrators learn at the same time how to use the iPad and what it will mean for their teaching” (p. 18). Similarly, an early study in tablet use in school with a Cooperative Learning environment found that the devices were especially useful in fostering productive collaborative learning while improving interactions between peers and instructors, “where students are engaged in higher level thinking activities such as problem solving and discussion of complex ideas” (Shuler, Hutchins, & LaShell, 2010, p. 11). Likewise, a higher education study of over two hundred undergraduate students closely measured perceptions of the iPad when used as “a supplemental learning tool in the classroom,” finding perceptions to be, on the whole, quite positive and noting that the device aided problem solving, connection of ideas and improved participation and interaction (Rossing et al., 2012, p. 1, our emphasis).

These strengths and weaknesses flagged in recent research reflect underlying concerns in many education institutions that smart mobile devices may not have, up until very recently, represented viable alternatives to traditional computers. However, such concerns are often shaped by each school’s collective understanding of technology learning affordances, the existing curricula and pedagogical approaches. Ensuring that educators incorporate meaningful use of mobile learning is, in turn, contingent on the extent to which students are permitted – and even encouraged – to use smart mobile devices for their learning. For example, in a collective case study of several school contexts exploring the recent rapid uptake of personal devices (“most notably, tablets”) the authors note that in spite of growth in the number of students with smart mobile devices, their use in learning contexts needs to be properly established before further affordances may be realized:

> In one year’s time, the percentage of middle school students with tablets jumped to 52 percent, a doubling over the 2011 percentage. Despite this proliferation of mobile devices in the hands of students, schools are still reluctant to allow usage of such personal devices. Amongst high school students with smartphones, only approximately half say they can use their device at school (36 percent of 9th graders and 42 percent of 12th graders). Only 9 percent of all students say they can use their personal tablets at
school... Today's digital learners are, therefore, caught in the cross hairs of a new mobile device dilemma. If you have a mobile device, you are probably not allowed to use it at school (Project Tomorrow, 2012, pp. 4–5).

Thus, in spite of rapid growth and unprecedented access to highly sophisticated, portable and low-cost technology, exploring the educational use of mobile devices remains a key challenge for future educational research. As Pilgrim, Bledsoe and Reily (2012) point out, “although schools and universities are investing in technologies such as the iPad tablet, educators are struggling to keep pace with the speed of technological development and demand” (p. 16).

4. From Text to Speech and Gesture

While attempts to explore the affordances of mobile devices have been marred by their comparisons with traditional computing tools, it is important to note that device interfaces have changed to the point where the ways tablet devices are used represent a considerable departure from longstanding interfaces such as the computer mouse (over forty years old) and QWERTY keyboard (over one hundred years old). More importantly, this departure reflects the broader historical trends from text-based interfaces to visual interfaces. While the preference for these older interfaces persists in many learning and workplace contexts, when compared with the more visual interfaces of gesture, speech and touch on smart mobile devices, their use also serves as a reminder to avoid judging tablet devices on how well they achieve traditional computing tasks.

Figure 1 illustrates the evolution of device interfaces in relation to multimodal forms of representation. In particular, the diagram shows the proliferation of options for creating content in terms of hardware/software interfaces that support earlier keyboard and mouse (graphical) input alongside more recent developments in voice recognition and gestural control. Further, where computing in an earlier PC era was largely device specific and “disconnected,” opportunities now exist to collaborate and communicate through a range of always-on, highly connected Web 2.0- and Cloud-enabled devices and convergent interfaces.

Figure 1: Text to Visual: Evolution of Device Interfaces and

At the same time as tablet technology has expanded the range of educational affordances and options for interacting with new interfaces such as voice recognition, gesture and touch, questions around the effective use of these devices in school settings remain. As Foote (2012) notes in a study exploring the 1-to-1 deployment of iPads in schools:
Will the iPad’s portability, ability to be personalized, and functionality impact its effectiveness in a school setting? In answering this question, so much depends on the purposes for which it is intended, the pedagogy accompanying its use, training afforded to teachers, the methods for implementing the new technology, and the tech support provided (p. 15).

5. Visualizing Solutions: Exploring Apps in the Classroom

Accompanying the changing technologies, is a changing approach to software deployment. This trend sometimes called “atomization” refers, on one level, to the separation into multiple, smaller applications (“apps”) of software traditionally grouped together in legacy software suites. Examples of this include numerous software-as-a-service (SaaS) applications available online through Web 2.0 and Cloud services, many of which see a wide-scale movement away from traditional computer uses such as word processing in productivity suites like “Office” suites. On another level, Atomization is particularly prevalent on smart mobile devices, where emerging uses of the device itself – including its mobile nature, the touch- and gesture-based interfaces, cellular Internet connectivity and other features like accelerometers and cameras – are coded into small apps, hundreds of which may be installed on any one device. The low-cost nature of these apps (many of which are free, others usually little more than a few dollars) means that educators and students have relative freedom to explore their affordances and, more importantly, sequence them meaningfully together in a diverse range of learning activities. In other words, the “atomized” nature of the available apps informs the flexibility with which they may be integrated into both current and future literacies.

There are now arguably an overwhelming number of apps available to teachers and learners. While some of these have been developed primarily for educational use, others used outside of education have been appropriated for their educational relevance. By contrast to many traditional desktop applications – where training and manuals have often marked the learning process – teachers and learners usually learn how to use apps through experimentation, play or trial and error. While this form of participatory learning (Clinton, Purushotma, Robison, & Weigel, 2006) often reflects free learner inquiry in many online contexts, in practical terms it is not possible for teachers or learners to become expert in the use of every app, educational or otherwise. The sheer number of apps available therefore presents both conceptual and practical challenges for educators seeking to visualize and explicate the learning process. As with their deployment of mobile technologies, many schools have responded differently to the challenges presented by an overwhelming array of apps, often involving teams of teachers comprehensively exploring affordances, aligning use with curricula objectives and scaling use across classrooms and grade levels. Some schools have chosen to mandate a set of “core apps” for common purposes across the school context, others leave the decisions about which apps to use in the learning process up to individual teachers and learners.

There is a small (but steadily growing) body of research on the educational use of apps in the classroom. While several studies point out the benefit of apps for learning (Crichton, Pegler, & White, 2012; Culén & Gasparini, 2011; Geist, 2011), others highlight a range of issues to be addressed. Research has, for example, considered the challenge of making meaningful use of apps when such a large number often overwhelms the selection process. In one review of four thousand mathematical apps on iOS (more apps than any teacher, learner or school could conceivably explore), Bos and Lee (2013) disappointingly found that “most are simple flashcard, numeric procedures of mobile textbooks... and do not support sense-making... active learning, or integrated visual models” (p. 3655). Related findings by Highfield and Goodwin (2013) suggest the limited range of pedagogies evident in apps and dominance of instructional and fluency-based apps is problematic for teachers. Similarly, in a general review of educational iOS apps that rated apps on several criteria including grade relevance, content area, curriculum standards and customer ratings, Watlington (2011) reports mixed results, with a maximum 50% of apps linking to relevant curriculum standards, subject areas and grade levels. The review also notes that while some areas such as English language, literature and the arts are reasonably well represented, others – Science, languages other than English and music – appear considerably less so. In other studies exploring the use of Android apps, White and Turner (2011) note the potential of the Android as a more open platform for coding and app development – encouraging learners to more fully explore the device as programmers. However, as Peng et. al. (2012) point out, when compared with iOS, the Android platform remains considerably prone to many malicious apps, with users (especially children) often granting apps control over core features of the device and increasing the risk of misuse and malware. Overall, the general lack of robust studies of Android devices in educational settings is itself a challenge for future research.
In spite of these challenges, the learning benefits of apps – in what is now a changed technology paradigm – are apparent. Early research identified the potential for more personalized, situated and often “just-in-time” learning given the diversity of available apps and their relative ease of use on highly portable devices, arguing that the technology can often be “invisible within the learning experience” (Melhuish & Falloon, 2010, p. 6). Likewise, Whitehouse (2011) describes the development of the concept of blurred learning, which she refers to as a seamless environment with learners “often working synchronously across distance and at the same time working face-to-face with a group” (p. 145). Noting the relevance of iPad apps in teacher professional learning, Chandler and Redman (2013) discuss connected, collaborative ways of note-taking, concept mapping and ideas sharing amongst teachers, suggesting that the iPad is “a tool that can support social, collaborative and exploratory communication experiences” (p. 61). These findings underscore the potential of apps, when used meaningfully, to provide immersive, situated and social learning experiences with very few technical barriers to their use, compared with those often present in more complex operating systems, or inherent when working across complex platforms and devices.

Functional literacy is arguably a key area in the literature where immersive learning experiences with smart mobile devices are well reported. For example, exploring a range of apps for English as a Foreign Language (EFL) learning, Meaurant (2010) draws attention to the confluence of the well established industry for EFL studies in South Korea and very high levels of technology use in what is commonly regarded as “the most wired nation on earth” (p. 224). This study of iPad apps for EFL learning in several colleges found that the availability of English language apps and the portability of iPads are especially useful for typical EFL classroom settings, where students “often alternate between whole-class activities and diverse individual, paired and small group tasks” (p. 228). In another study of illiterate migrants in Switzerland, Knoche and Huang (2012) found that participants – who could not read or write in either their native or adopted languages – nonetheless formed ways of expressing themselves and their identities through their smart mobile device, essentially using the tool as a bridge to the visual forms of expression that were available to them.

Exploring literacy for native English speakers, Hutchison, Beschorner and Schmidt-Crawford (2012) similarly emphasize the important relationship between tablet use and new media literacies as situated, embedded practices (Lankshear & Knobel, 2007). They note that the digital texts (increasingly in the form of iPad apps) are more oriented around literacy as doing, and as such, require different skillsets to decode, analyze, interpret and compose:

One way the iPad provides potentially useful opportunities for literacy classrooms is through digital, interactive books. However, it is important to consider that digital texts, as compared with printed texts, offer different affordances that create new modes of reading and writing. Accordingly, digital texts can require different skills, strategies and dispositions, collectively referred to as new literacies to read and navigate them. Thus it is important that teachers understand these differences and integrate digital technology into the curriculum to provide students with opportunities to learn these new literacies (p. 16).

Given the increasing popularity of eBooks, including the growing collections of highly interactive and multimodal e-textbooks, educators will no doubt continue to explore tablet devices as tools for enhancing literacy experiences, engaging reluctant readers and redefining the nature of the “book” in the twenty-first century. However, an important corollary to be considered when exploring literacy as doing through the use of mobile devices and apps is learner creativity. Foote (2012) draws attention to the creative power of the iPad, noting that in many educational contexts, “it has spurred creativity... because of the [still] camera, video camera, and the apps that can be used for creative storytelling and video production” (p. 16). The use of apps for creativity has prompted further development particularly in the area of Digital Storytelling, now considered a well established mode for new media literacy in the classroom (Ohler, 2013). For example, in their study of iPad apps Storykit and Storyrobe for Digital Storytelling in upper elementary school classrooms, Reid and Ostashewski (2011) found that students demonstrated high conceptual understanding and creativity using these apps, and that students of all abilities “found success with the iPads in a number of ways.” The study further reports that students were able to integrate the use of other apps such as Speak It! to build audio material to incorporate into their projects, noting that their confidence and abilities to work independently improved while teachers felt comfortable with not needing, as one teacher put it, “to be the guru of technology” (p. 1664).
Pilgrim, Bledsoe and Reily (2012) also explore the relationship between improved learner confidence and the increased number of ways to demonstrate literacy through creativity apps, drawing particular attention to apps that enable learners to demonstrate and “teach”:

Apps can serve as portable interactive whiteboards. ShowMe, Educreations Interactive Whiteboard, and ScreenChomp are free downloads that record pen strokes and audio simultaneously. Then the user can post the recording online for others to access. These features can be used in any content area but are especially helpful in recording math problems with audio instructions. Students can also record their own audio or video clips to demonstrate understanding (p. 19).

Finally, in a longitudinal study that explored iPad deployment and use in a large, K-12 setting, Gasparini (2011) found that device ownership was a very large factor in students making meaningful, sustained use of apps on what was considered “their” device. This use was contrasted when iPads were simply deployed in trolleys and available for classroom use alone – an argument that lends considerable weight to the Project Tomorrow Report findings on the importance of students personalizing their devices (Project Tomorrow, 2012). Gasparini’s study found that in relatively short time when given the opportunity, students were able to personalize their devices with appealing themes, colors and additional apps that they considered appropriate for their learning. The visual nature of this personalization is evident with the range of screenshots taken a short time after students were allocated their device:

![Image](Image used with Permission: Gasparini, 2011, p. 33)

**Figure 2:** Personalized Apps, Layout and Themes on Student-Owned iPads

The study further reports that, with the provision of personal devices, students could more freely choose apps that were both relevant to the task and supportive of their learning needs. For example, when working with digital stories, some students chose to use different apps for the task, and were able to reason why:

What made the difference here was their perception of their own ability to capture the object that was to be animated. The iPad’s touch interface did not remove this barrier. The children who had problems with drawing were drawn to Puppet Pals, as they felt that their creativity could be expressed through the story itself rather than through the drawing of the story’s characters. This was highlighted by one child’s statement: “You know they have in some way draw it for you, so if you are not so good, you manage to make a story anyway!” (p. 44).

In light of the enormous potential for apps in the classroom, further theorization and discussion of how learning processes are conceptualized is warranted. In particular, the visualization of the learning process represents an important consideration in meaningfully sequencing apps to align with twenty-first century pedagogies, while overcoming challenges and realizing most – if not all – of the learning benefits canvased thus far.

6. **Pragmatist Theory and Apps as “Cognitive Stepping Stones”**

Regardless of how apps are discovered, explored and integrated into teaching and learning, there is arguably a need to address where they fit into key stages in the learning process. This section of the paper examines the
potential of open-ended and “constructive” apps as tools in a visualized learning process. A sizable body of research has explored the importance of visualizing and verbalizing learning processes to enhance instructional design (Sweller, 2002), aid language comprehension and scaffold thinking (Bell & Lindamood, 1991), or as a way of teaching students cognitive strategies such as “getting unstuck” and developing skills of metacognition (Loughran, Mitchell, & Mitchell, 2002). With so many available apps, visualizing the learning process is arguably more about presenting appropriate options for learners at different stages within the learning process. Figure 3 illustrates some of the possible ways of configuring current apps for different stages of knowledge construction within a typical inquiry process. At the time of writing, a number of high quality apps that were first developed for iOS have been ported to Android. Figure 3 indicates whether the app runs on iOS, Android or both platforms (“cross-platform”). While future research might explore the potential of the emerging Windows Mobile platform, much of current app development is focused on the two current dominant platforms:

![Figure 3: Apps for Learning Processes](Image used with Permission: Hedberg & Reeves, In Press)

As represented above, visualizing the key stages, processes and options for the learner often reflects the research paradigm, instructional model or learning theory. Learner-led inquiry is a common feature of many current technology-mediated instructional models such as Inquiry-Based Learning (Owens, Hester, & Teale, 2002), Project-Based Learning (S. Bell, 2010) and Cooperative Learning (Kagan & Kagan, 1994). This form of inquiry (for example, as part of the process depicted above) arguably traces its theoretical roots to pragmatism and the work of John Dewey, for whom learning is grounded in activity and experience. Dewey (1916) saw the development of human knowledge as an adaptive response to the environment, arguing that learning “cannot take place by direct conveyance of beliefs, emotions and knowledge... it takes place through the intermediary of the environment” (p. 12, our emphasis). Accordingly, he defined the environment as “whatever conditions interact with personal needs, desires, purposes and capacities to create the experience which is had” (Dewey,
Dewey emphasized the importance of learning tools that emerge from shared social concepts (Eldridge, 1998). As Glassman (2001) elaborates, Dewey’s “socially-developed tools... serve as reference points for the individual as she attempts to navigate life situations,” but, importantly, “when the tools no longer have pragmatic value they are modified or rejected by the individuals using them” (p. 5). In many ways, Dewey’s idealized form of learning is problem-solving through free, learner-directed inquiry, which he saw as “the self-controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole” (Dewey, 1938a, p. 108). In this context, pragmatist epistemology has often been associated with design thinking, or learner experience that involves the design of solutions through the inquiry process.

Apps encourage the implementation of design thinking and creativity as the learner moves through each stage of the inquiry process. As Figure 3 suggests, this often involves effective sequencing of apps for specific purposes, but should also involve critical thinking about which apps are best fit for purpose at each stage. When combined in meaningful sequences, apps enable the transformation of data from one representational form to another, supporting development of multiliteracies through multimodal forms of representation and interpretation. Alongside representation, appropriate use of apps in the inquiry process can support the learner’s conceptual understanding, providing tools for the scaffolded development of ideas to frame increasingly complex thinking. For example, cross-platform (iOS/Android) apps such as Lino and Mindmeister support ideation through scaffolding ranging from semi-structured to highly structured, while ThinkPal suggests thinking strategies based upon the learner’s current cognitive impasse and Star Walk enables the learner to scaffold direct experiences as they point their camera to the heavens and gain assistance interpreting the sky they are observing.

As Pilgrim, Bledsoe and Reily point out, “varied digital technologies provide teachers of any content area with a different approach to integrating the skills of the 21st century” (p. 17). By visualizing apps as cognitive steppingstones in the learning process, teachers and learners are encouraged to incorporate a wider range of skills and modalities into the learning task. Hutchison, Beschorner and Schmidt (2012) explore the technology and literacy skills required in the transformation of data in different representational forms. In their study, upper-elementary students used a range of iPad apps to visualize, order, interpret and represent meaning when responding to and composing written texts. For example, during the visualization stage:

...the researchers located an iPad app called Doodle Buddy that students could use to draw their illustrations. This app was selected because of its intuitive interface and drawing features that create the effect of using many different drawing tools, such as colored pencils, chalk, paint brushes, glitter, stamps, and so on. The app also allows users to insert photos, undo their last action, and easily alter between multiple tools and colors. Additionally, drawings can be exported through e-mail or saved to the iPad photo album so that the drawing can be viewed later or inserted into a different app (p. 18).

Further, the researchers employed the use of Popplet to “represent the main events in the [learning] sequence, connecting them with time-order words.” To enhance their retelling of the narratives, students sequenced and annotated their illustrations in Strip Designer, while Sundry Notes was used to explain cause and effect in the narrative by inserting students’ audio comments on an instructional-level text to explain their understanding. As one child noted during interview, using apps like Popplet “helped with comprehension, because we picked out main ideas and when we had to put them in order,” while another child noted that using apps to annotate text and images meant that, “you have... a reason to think about the book instead of just like letting it kind of go over your head and... not remembering anything.” (pp. 19-20).

In another case study of iPad apps in an upper-elementary Social Sciences classroom, Berson, Berson and McGlinn-Manfra (2012) discuss the potential of the iPad as “a conduit for fostering classroom community building as well as promoting social studies learning goals” (p. 88). In particular, this study looks at the sequencing of apps and visualization of the learning process in an inquiry unit on the Caribbean and the effects of the 2010 earthquake on the region. In a largely teacher-led series of activities (limited by the availability of only three iPads among the fifteen students), the class primarily used the app My Haiti: Valdo, a Child’s Story to generate empathy for victims and survivors of the earthquake. Students then linked this empathy activity to a range of apps for different purposes and modalities with a view to expanding their understanding of the
issues and actively researching answers as part of the learner inquiry process. Figure 4 demonstrates the form that this learning process took, including how the apps were employed as “puzzle pieces” in the larger learning process:

![Diagram of visualized learning sequence in social studies inquiry learning](image-used-with-permission-berson-et-al-2012)

Figure 4: Visualized Learning Sequence in Social Studies Inquiry Learning

Interestingly, the process depicted here reflects the use of a wide range of apps, interfaces, modalities and literacies while not specifying a clear sequence, often a feature of many project- and inquiry-based learning models (Buck Institute for Education, 2014; New Tech Network, 2012). This process culminated in “writing stories that depicted the effects of the 2010 earthquake on the region, using multiple apps to support their creativity, collaboration, and communication” (p. 88), but integral to the success of the final task was the need to develop a diverse skillset through the apps employed.

As these examples demonstrate, visualizing and sequencing the learning process through the meaningful use of apps has the potential to support twenty-first century pedagogies and extend the range of digital skills and new media literacies. When combined with the low technical barriers to using apps, the portability and growing affordances of tablet devices, there is potential for creating highly immersive and collaborative learning environments with “invisible” technology and a clear focus on authentic, situated, learner-led inquiry.

### 7. Frameworks Moving Forward

In the years before the impact of highly personal, smart mobile devices, the focus on technology in educational institutions has dwelt on the expensive and relatively fixed technology infrastructure necessary to enable unified ways of learning within the institution. In many cases, the choice of specific hardware often dictates the software used in education. For example, institutions choosing to deploy computers (running under MacOS) provide access to specific tools that many learners have come to associate with creativity (GarageBand, iMovie), whereas the decision to deploy Microsoft Windows-based PCs provides access to software often associated with productivity (Microsoft Word, Excel or PowerPoint). These decisions often reflect the reality of a learning environment that is, to a fair extent, centrally controlled and administered, for example, by IT personnel who may be removed from teaching and learning strategies. Their decisions have held implications for key infrastructural, pedagogical and broader organizational changes within the institution, such as the many 1-to-1 technology device programs, the use of specific hardware and software for instructional delivery such as interactive whiteboards (IWBs), data projectors, and computer laboratories. Most often, the emphasis is on common, or agreed technologies and standards that are deployed throughout
the institution; their use may be encouraged, or even mandated, and alternative technologies might be
discouraged, or even “blocked.” While representing an older paradigm, the legacy of infrastructure-led designs
still persists today.

In many ways, however, the rapid development and wide scale adoption of mobile devices represents a
marked departure from these infrastructure-led designs. While many educators and institutions have
continued to wrestle with understanding, implementing and supporting a growing number of tools, platforms
and standards, the impact of overarching, multi-platform trends like Cloud- and Web 2.0-based technologies
point to the idea of what some have predicted and now regard as “device agnosticism” and “convergence”
(Garner, Zoller, Trotter, & Anderson, 2005; Prince, 2011). For example, iOS, Android, MacOS and Windows
apps like Evernote (a tool for storing, cataloguing and tagging notes and media), Dropbox and Google Drive
(tools for saving and retrieving files using online storage) all enable content sharing across devices and
platforms – and these tools have become the bedrock of many successful Bring-your-own-device (BYOD)
initiatives (Eschelbeck & Schwartzberg, 2012; Grussendorf, 2013; Romer, 2014). As we have seen, there are a
rapidly growing number of web-based, Web 2.0 and mobile apps that also emphasize people-to-people
interaction, very often occurring in real-time and without the need to assume the same physical space. As our
personalization of technology devices and tools deepens at the same time as increases to the number and
scale of our interactions with others online, many have come to expect that much of our data will be
accessible 24/7, from any device, stored “in the cloud.” These realizations present enormous opportunities at
the same time as presenting considerable challenges.

In drawing conclusions about their students’ use of a wide range of apps, Hutchison, Beschorner and Schmidt
(2012) maintain that “teachers should select appropriate activity types and assessment strategies before
making a final selection about which technology tool will be most useful” (p. 21). By designing the learning task
as, in a way, independent to the technology, the teacher is arguably better equipped to carefully and
purposefully select apps as cognitive steppingstones within the learning task, resulting in tasks that more
consistently challenge students to develop a wide range of digital skills. Goodwin and Highfield (2013) also
highlight the key role of the teacher in the teaching and learning process. They suggest that teachers examine
the underlying pedagogy of the technology they select and focus on aligning the pedagogic design of the
technology to their intended classroom goal. Berson, Berson and McGlinn-Manfra (2012) note, through the
use of carefully selected and sequenced apps, students “learn a new form of literacy as they move between
apps and engage in both personalized and collaborative learning experiences” (p. 89). At the same time, by
carefully framing the learning process with key stages and sequences, both students and teachers can more
easily substitute apps. Such substitution may be necessary, for example, in cross-platform environments where
different apps exist on different platforms, or in circumstances when new apps are released to replace older
ones. One key element in the use of apps that is arguably imperative moving forward is the need for
collaboration and communication across devices, platforms and networks. As this discussion has shown,
market pressures have led to high quality educational apps being available for the dominant platforms, and
this is a trend likely to continue. By promoting technologies that easily interface between devices –
smartphones, tablets, desktops and laptops – educators better ensure that the future technology device
debates are not “either/or,” but “both/and” and support sharing and collaboration. At the same time, it is
important to be mindful of what Rideout, Saphir, Tsang, and Bozdech (2013) term the “app gap,” wherein
lower-income children (ages 0-8) have more than 50% less experience using mobile devices than higher-
income children in the same age group” (p. 10). Most importantly, promoting more learner-led solutions, for
example, by embracing the many devices and platforms that students already have, schools can avoid the
limitations of legacy infrastructure-led solutions that impose a non-pedagogical technology solution on
learning.

8. Conclusion

That education is not an affair of “telling” and being told, but an active and constructive process, is a
principle almost as generally violated in practice as conceded in theory. Is not this deplorable situation
due to the fact that the doctrine is itself merely told? It is preached; it is lectured; it is written about. But
its enactment into practice requires that the school environment be equipped with agencies for doing,
with tools and physical materials, to an extent rarely attained. It requires that methods of instruction
and administration be modified to allow and to secure direct and continuous occupations with things
(Dewey, 1916, p. 36)
This paper has reviewed some of the many challenges and opportunities that line the journey towards schools using smart mobile devices for authentic, situated and immersive learning. By critically examining the use of apps as part of a pragmatist theoretical framework for smart device mobile learning, we argue that these technologies function as tools for learning grounded in experience, purposeful action and inquiry. Parsons (2014) has suggested that the future of a world of smart devices with focused apps to support cognition enables new pedagogical strategies that:

1. place learning in specific contexts and the device with its apps enables the learner to collect, organize and share with the one device;
2. overlay reality with virtual information;
3. no longer simply follow a highly pre-structured path but enabled to contribute to the creation of shared learning resources;
4. provide an adaptive toolkit in the palm of the hand. One that enables the user to include spatial data and track the source of changes; and
5. enable the learner to take ownership of their learning (2014, pp. 221-223).

Inherent in this position is the importance of promoting choice whenever possible. While some schools offer choice very broadly by encouraging students to bring in any device through BYOD, other schools implement whole-of-school technology programs that see the deployment and use of one main device. Regardless of the direction that is taken, the diversity of software platforms and apps now represents choice on a “micro” level at a “macro” scale. Students are, more than at any time in the past, able to determine which technology tools will be suitable for each stage of the learning process. With recourse to the case studies discussed, this paper has shown that choice can operate in a number of ways. At the same time, many schools maintain large infrastructure-led solutions where specific hardware and software are mandated, representing environments where it remains very difficult to capitalize on the benefits of personalized mobile devices. Nonetheless, it is important to remember that the education community has an important voice in technological change. Just as Dewey argued that the makers of the tools should not dictate how they are to be used, educators and learners have a responsibility to challenge technology giants and software developers to meet their needs in a changing world. By visualizing learning processes and exploring apps as cognitive steppingstones, teachers and learners are more able to recognize what they need from technology and work pragmatically and openly to address these needs for many years to come.

References


Staff Development and Institutional Support for Technology Enhanced Learning in UK Universities

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Abstract. This paper presents the findings of a mixed methods study conducted in the context of Higher Education Institutions (HEIs). More specifically, it focuses on the staff development needs of tutors who teach in blended and online environments, the ways HEIs in the United Kingdom (UK) address these needs and institutional issues around the deployment and support of Technology Enhanced Learning (TEL) by campus-based institutions. The informants in both phases of this research were the heads of e-learning in various UK HEIs. Using an online questionnaire, quantitative data were gathered on the various ways that the staff development needs of the lecturers in blended and online learning have been addressed by UK HEIs. During the second phase of this research, eight semi-structured interviews were conducted. The findings from both phases are integrated in the results section of the paper.

Keywords: staff development; technology enhanced learning; blended learning; online learning; HEIs

1 Introduction - Background literature on staff development and institutional support in the area of TEL

TEL is an inclusive term that encompasses blended learning, distance learning and even classroom-based activities assisted by digital technology. The Higher Education Funding Council for England (HEFCE) is now using this term as a replacement of the term e-learning which 'can now sometimes be too narrowly defined to describe fully the widespread use of learning technology in institutions' (HEFCE 2009, p.1).

The UK Professional Standards Framework (UKPSF), endorsed by the Higher Education Academy (HEA) recognises the professional standards for those involved in teaching and supporting learning within UK HEIs. In its core knowledge category, which describes what is needed in order for the various teaching activities to be executed at a high level, ‘the use and value of appropriate learning technologies’ is included (HEA UKPSF, 2011).

The constantly increasing integration of learning technologies in the curriculum in the 21st century, such as VLEs and web 2.0 software, has made the pedagogy of TEL more central to university practice. Therefore, staff development activities in the area of TEL become increasingly important. However, blended and online course provision takes a lot of planning and requires IT infrastructure, platforms, administrative processes and online tutors-moderators in order to succeed. Many authors (Garrison & Vaughan, 2008; Laurillard, 2002; MacDonald, 2008; Palloff & Pratt, 2007; Salmon, 2003; Tait & Mills, 1999 & 2003) have highlighted the fact that, for online learning to succeed, staff development is of crucial importance. According to MacDonald (2008, p.177):

>The effectiveness of a blended course will be greatly influenced by the skill, enthusiasm and availability of the staff who work on it. They will need staff development to be effective, unless they already possess the relevant experience.<

Moreover, Salmon (2003, 2011) argues that an online tutor-moderator needs to develop technical skills but more importantly, become aware of new teaching practices that can be implemented online in order to become effective facilitators in online environments.

Laurillard’s (2002, 2012) conversational framework for the effective use of learning technologies emphasizes the need for an effective organisational infrastructure to be in place. According to her, a learning organisation needs to be adaptive to the changing environment they find themselves in. Laurillard’s framework is a dialogic (conversational) process that takes place on two levels: the discursive level with a particular focus on theory and conceptualising, and the experiential level where the focus is on practice, activity and procedure building. While both levels are interactive, interactions at the discursive level are taking place within the members of
the community whereas in the experiential level the interaction is rather adaptive; in other words the individual in the experiential phase is trying something new, adapting their actions depending on their results. Laurillard’s conversational framework for instruction accommodates continuous interactions between the instructor and the learners through various media types. The online environment is used in order to facilitate learners’ adapted actions and conceptions through reflection based on the instructor’s feedback; the whole process is rather dynamic, as the instructor takes into account the learners’ previous actions in order to modify the description of the task and tailor his/her feedback to the learners.

Staff development is critical in the implementation of TEL in one’s practice (Garrison & Vaughan, 2008; Laurillard, 2002; MacDonald, 2008; Palloff & Pratt, 2007; Salmon, 2003; Tait & Mills, 1999 & 2003). Currently, there is a variety of approaches to staff development on blended and online learning including staff training sessions, workshops, seminars, CPD short courses and online resources. (Almpanis, 2012) Also, pedagogical aspects of online learning are often covered as part of the Postgraduate Certificate in Learning and Teaching or else Postgraduate Certificate in Academic Practice (PGCLT/PGCAP) course aimed at new lecturers. (Almpanis, 2012). These approaches currently in use by UK HEIs for staff development in the area of TEL coupled with wider institutional considerations in the area of TEL are the main focus of this research.

2 Research design – Methodology

The research design has been selected in order to align with the main research questions of this study, which focus on the staff development needs of the academic staff involved in blended and online course delivery. The main questions of this study are:

1. What provision do UK HEIs make for staff development in the area of TEL?
2. According to the heads of e-learning, what do lecturers need to know in order to deliver blended and online learning courses effectively? Are these needs addressed by UK HEIs?
3. What institutional approaches are required for TEL to be effectively embedded in the curriculum?

A mixed methods research (MMR) design was adopted for this research as it can best address the complexity of these questions. The first research question is mostly addressed based on quantitative data gathered via an online questionnaire, while the second and third questions are addressed qualitatively, based on data gathered via semi-structured interviews with eight heads of e-learning (HeLs) The sequence for data gathering used was: the questionnaire was sent out in late October 2011 and it was open for three weeks until the middle of November 2011, while the interviews took place between January and March 2012. Both data collection methods used the same informants, the HeLs, for consistency and reliability purposes. However, the interviews used a smaller sample – eight – compared to the questionnaire, which returned 27 responses out of 118. The selection of the heads of e-learning to be informants of this research provided a number of advantages such as fair representation of UK HEIs, as each UK institution can have only one representative in the heads of e-learning group.

The interview data were coded by open-coding, a procedure by which the data were conceptualised. Subsequently, a list of conceptual categories was created. The survey of the literature offered useful background knowledge and informed the creation of the questionnaire and the interview questions, but also was subsequently used to enrich the discussion of the research results.

2.1 Data analysis

Initially, quantitative data were gathered on the various ways that the staff development needs of the lecturers in blended and online learning have been addressed by UK HEIs. Simple frequencies and cross tabulations were applied to the data. The interview case studies have been written as descriptive narratives first and following open coding, various themes emerged. Open coding was used initially to uncover, develop and name concepts in order to open up text and expose the thoughts and ideas contained within them. Following that, broader categories (themes) have been developed. Once saturation occurred in categories and no more information was able to be extracted, categories were then integrated and refined. Findings from both phases are integrated in the results section of this paper in which the two data sets are merged by bringing the separate results together in the interpretation. The quantitative data analysis proceeded from descriptive to inferential analysis in order to build a greater refined analysis. Qualitative data
analysis began with coding and proceeded to creating categories (themes). This is in line with Creswell and Plano Clark (2007, p.137) according to whom:

Two techniques are available for merging the quantitative and qualitative data: Transform one type of data to make the qualitative and quantitative datasets comparable and then compare the datasets, or compare the data without transformation through a discussion or a matrix.

The latter way of merging qualitative and quantitative data – through discussion – was followed in this research due to the fact that some of the data gathered were complementary rather than directly comparable.

2.2 Research generalisability – legitimacy – reliability

The validity of the data and the results is an important component of research. According to Creswell and Plano Clark (2007) in quantitative research, validity means that the researcher can draw meaningful inferences from the results to a population. In this context, the quantitative data gathered via the online questionnaire are, if not representative, at least indicative as the 27 participants out of a possible 118 represent over 20% of the HeLs who subscribe to the HeL forum in the UK. As the questionnaire was e-mailed to all HeLs twice, there was no selection bias either. In terms of self-selection bias, it could be a possibility that those with the stronger views on e-learning might have volunteered themselves to participate in further research and be interviewed, but this was anticipated from the beginning. The interviews aimed for in-depth data to be gathered knowing that due to their small number, interview findings would be illustrative rather than representative.

In terms of the qualitative data gathered through the interviews, 13 of the questionnaire respondents volunteered to participate, providing their institutional email address in order to be contacted for an interview. Ten out of them were contacted based on the richness of their responses to the questionnaires, and the eight who responded were interviewed via Skype. The informants represented a wide range of UK HEIs as there was an equal split between pre-1992 and post-1992 institutions with four participants of each. Participants represented institutions that included members of the Russell group and other research-orientated institutions, but also other, more teaching-focused institutions from different parts of England and Wales.

As this is a mixed methods study, validity is defined as the ability to draw meaningful and accurate conclusions from all the data in the study. Thus validity in this context denotes the ‘inference quality’, the accuracy with which the researcher draws inductive and deductive conclusions (Tashakkori & Teddle, 2003). This research is only to a certain extent generalisable, as it indicates the situation of how TEL is approached by over 20% of UK HEIs from expert informant perspectives; due to the different ways universities in other countries may be structured, its findings and conclusions may have limited transferability to other contexts, but still it might be of interest to them for reference and for comparative purposes.

3 Results

This section discusses the findings of both phases of this research by merging the two data sets and bringing the separate results together in a holistic interpretation.

3.1 Staff development opportunities around TEL

Most universities represented in the survey offer a wide variety of staff development sessions/events for their academic staff that covers a range of skills and pedagogical considerations of various learning technologies. This shows that participating institutions are trying to up-skill their staff by addressing their needs in the area of TEL in a flexible manner, offering them plenty of choice.

The duration, frequency and uptake of the training sessions varied widely; some institutions offered training sessions at regular intervals to suit the academic timetable, others 3 to 4 times a year. However, most institutions would deliver tailored sessions on request for specific departments or course teams and there seems to be a shift towards small group training and one-to-one training on request.

The offerings for training in the use of various learning technologies to academic staff reflected the uptake and usage of those technologies as discussed in the interviews. The use of VLEs for content delivery were the most popular staff development sessions, as training sessions on their use were provided by all institutions participating in the survey as shown in figure 1. Furthermore, the vast majority of institutions that participated
in the survey offered organised events on the pedagogically effective use of the VLE as shown in figure 2 and offered online case studies too, as shown in figure 3.

**Figure 1:** Responses to the question ‘Does the university offer any of the following hands-on training sessions on how to use the following tools? Please tick all that apply’ (Percentages shown above are out of 26 responses).

**Figure 2:** Responses to the question ‘Does the university offer any of the following workshops/seminars/internal events or internal conferences on the pedagogically effective use of the following learning technologies? Please tick all that apply’ (Percentages shown above are out of 26 responses).

**Figure 3:** Responses to the question ‘Does the university offer any online case studies on the following learning technologies?’ (Percentages shown above are out of 20 responses).
Following the use of the VLE for content delivery, e-assessment seemed to be the most popular practice involving learning technology. Both hands-on training sessions and other events focusing more on the pedagogically effective use of e-assessment came up equally high and were on offer by most HEIs participating in the survey (figures 1 and 2) while two-thirds also provided online case studies (figure 3). This was also reflected in the interviews, as e-assessment came up high as a common institutional target for campus-wide TEL implementation among the interview participants. The deployment of e-assessment was reported to be a common institutional target in the interviews too.

Plagiarism detection and prevention via tools like Turnitin was also highly popular in hands-on training sessions offered (22 of 26 responses, figure 1) but also in events regarding its pedagogically effective use (21 of 26 responses, figure 2), which would probably be in the prevention of plagiarism. Eleven of the participating institutions also provided online case studies on plagiarism prevention and detection (11 of 20 responses, figure 3).

In terms of web 2.0 tools such as blogs and wikis, approximately two-thirds of participating institutions offered hands-on training sessions (figure 1) as well as workshops on their pedagogically effective use (figure 2) and online case studies (figure 3). These events/case studies would aim to increase uptake among staff and raise staff’s digital skills in order to enable them to support constructivist and social constructivist learning, utilising online tools.

Training on personal response systems (PRS), or else electronic voting systems (EVS), or clickers, was provided by two-thirds of participating institutions (figure 1), while half the institutions that took the survey were also offering online case studies on the use of PRS (figure 3) in order to add interactivity in the classroom enabling lecturers to ask students questions in the classroom, get real-time feedback from students and check their understanding on various topics. According to Mazur (1996) the use of PRS can transform a passive lecture to a more engaged, interactive one that can also support peer-instruction when students are asked to discuss their responses in pairs.

E-portfolio sessions were also popular among participating institutions; approximately three-quarters were offering training sessions (19 of 26 responses, figure 1), approximately half of them (14 of 26 responses, figure 2) were offering workshops or other events focusing on the pedagogically effective use of e-portfolios and approximately a third were offering online case studies on their use (7 of 20 responses, figure 3). E-portfolio systems can be used in courses with a strong reflective element and it was used in all physiotherapy courses in one case; it can also be used for assessment as shown in another case in which the e-portfolio was used for two of the assessments in the postgraduate certificate in teaching and learning course, so that lecturers would be able to support its use as personal tutors with their students. Indeed, e-portfolio systems can support flexible learning in professional, work-based courses in particular, as they offer participants a space to gather their evidence about their practice.

Hands-on training sessions on web conferencing software were on offer by more than half of the institutions participating in the survey (16 of 26 responses, figure 1), while slightly less than half offered workshops and other events on their pedagogically effective use (12 of 26 responses, figure 2) and 6 offered online case studies (6 of 20 responses, figure 3). Web conferencing tools can be used to bring together participants that are geographically dispersed, but as pointed out by one informant it can be challenging for some academic staff to use this technology and may require extensive training. This is also backed up from the relevant literature, according to which synchronous facilitation via web conferencing software can be demanding in terms of staff training (Reuschle & Loch 2008, Vitartas, Rowe, & Ellis, 2008; Wang & Hsu 2008).

Virtual worlds like Second Life were the least popular in terms of staff training provided among all aforementioned learning technologies; only 3 of the 26 institutions answering this question offered training sessions in the use of Second Life (figure 1), while 4 offered seminars on its pedagogically effective use (4 of 26 responses, figure 2) and 2 offered online case studies (2 of 20 responses, figure 3). This is likely to reflect the fact that the use of Second Life has not become mainstream in higher education and is only used by specialist departments in few institutions. Experiential learning via Second Life is also resource heavy and its use seems to be limited among participating institutions due to the increased and often non-sustainable amount of resources it requires (Gorman, 2012). This could be due to the fact that virtual worlds require a significant amount of upfront investment in order to work for educational purposes. The challenges for educational use
of Second Life include time, money, up-to-date technology and the amount of training required to become proficient in its use (Ash, 2011).

Other sessions on learning technologies provided by participating institutions were reportedly sessions on online media, screencasting, podcasting, lecture capture and other classroom audio-visual equipment, audio and video editing, iTunes, twitter and office tools. These sessions highlight the broad range of staff development sessions provided by some institutions that includes multimedia content creation and sharing – podcasting, screencasting, audio and video editing, lecture capture, iTunes – but also micro-blogging – Twitter – and office tools. However, no specific data on those sessions offered is attempted here, mainly due to the fact that these were not offered as one of the options in the questions but were added by participants in the ‘other’ field. Their lack of inclusion in the given options was due to the fact that the research focus was more on the established learning technologies supported institutionally rather than on applications that could be more popular in some areas than in others.

The technical skills required for effective online teaching can be varied depending on the task; however, basic digital and web literacies and an understanding of the system and the tools in use are said to be often adequate for the lecturers involved in such programmes, provided that this is coupled with a pedagogical understanding of the tools used, according to the HeLs. Institutions are trying to address these needs with ongoing staff development but a willingness to experiment with new tools and practices and adapt one’s practice from the lecturer’s side are also important. The pedagogical and technical skills are often interspersed; this is evident from the fact they are addressed jointly as part of the staff training programmes of some institutions.

In almost half the cases – 13 out of 27 – TEL was reported to be the focus of one of the modules of the Postgraduate Certificate in Learning and Teaching in HE. Similar was the case among the interviewees, as four out of seven mentioned that TEL was included as a separate module in that course. The PGCERT/PGCAP course is critical for new lecturers’ professional development (Donnelly, 2006; Matthews & Jessel, 2006; Schon 1987) and it is important that TEL practice is embedded in that course so that lecturers understand that TEL is part of their standard practice. The way institutions embed TEL in their PGCERT/PGCAP courses has not been standardised as yet; some have a whole module on TEL while others embed TEL in the whole course. A combination of the two, looking at TEL explicitly as part of the curriculum and also embedding TEL practice in the way the course is delivered and assessed may be the golden mean as this will offer the opportunity to new lecturers to study and discuss TEL’s potential but also reflect on their own experiences of using it as part of the PGCERT/PGCAP course.

Most institutions that participated in the survey provided a wide range of CPD opportunities around TEL. This is crucial for those who are already midway through their career as well as anyone who would need some development in the area of TEL. The need for all lecturers to be competent in the use of TEL is apparent and highlighted by the UK Professional Standards Framework which is devised by the Higher Education Academy (HEA, 2012) and sets the professional standards for teaching and supporting learning within HE. This is indicative of the fact that the use of learning technology to support, facilitate and enhance students’ learning has now become standard practice and is no longer seen as a separate skill, as discussed more extensively in the literature review chapter.

3.2 Drivers for institutional TEL-support implementation

The ‘student experience’ seems to be the most critical stated drive for the implementation of TEL across participating institutions. All other goals and targets around TEL, such as e-submission and e-assessment, developing staff competencies across the board and improving uptake, are a means to achieve an improved student experience and to raise levels of student satisfaction. This could be the result of the raised tuition fees and the increased competition among the UK HEIs for a shrinking student body (Ratcliffe, 2012; Taylor 2013). While raising students’ satisfaction is a reasonable target, there is a danger that TEL might be utilised mainly for administrative tasks that simplify the learning and teaching processes, missing out on its transformative potential to redesign the curriculum (Palloff & Pratt, 2007). The fact that TEL was used more for its administrative benefits rather than to its potential to transform learning was explicitly stated by two informants and was implied in the responses of some of the other informants too.
3.3 The question of prerequisites in terms of staff development for blended and online learning course delivery

Although in more than half of the cases there were no strict requirements for staff to undertake training/development before they got involved in blended learning, training opportunities were available and staff were strongly encouraged to participate; a few of the participants mentioned that for online courses in particular, staff would be expected to participate in some TEL-related personal development and also that staff development needs would have to be addressed during the course validation process. In one third of the cases there were some requirements that varied from a half-day VLE induction to a whole module, while in other cases staff development on TEL was tied in the course approval process. There was an interesting debate on whether there should be any prerequisites before teaching online or not; in order to teach online successfully, one needs to not only be knowledgeable in their subject and have some pedagogical awareness of current teaching and learning theories, but needs to have experience of online learning and follow an explicit learning design in the delivery of their module. The question of prerequisites seems to be a double-edged sword; on the one side, putting prerequisites may slow down and even prohibit innovation as it would create an extra level of scrutiny and on the other without prerequisites there is a risk that the course may not be up to the highest standards. In other words, if TEL and one’s ability to teach online or in a blended course is seen as something additional to a tutor’s responsibilities, this fact might limit the wide adoption of blended and online courses in some cases. At the same time, in order for such courses to be delivered effectively, all participating tutors need to have an understanding of technology and the way it intersects with their subject matter and with pedagogy too. This is in accordance with the Technological Pedagogical Content Knowledge (TPCK) concept which emphasises the interactions, affordances and limitations among content, pedagogy and technology:

Quality teaching requires developing a nuanced understanding of the complex relationships between technology, content and pedagogy, and using this understanding to develop appropriate context-specific strategies and representations (Mishra and Koehler, 2006, p.1029).

Although the TPCK model was not discussed or mentioned by the research participants, they underlined the importance of all its elements; according to research participants, in order to deliver blended and online courses effectively, lecturers need to have some pedagogical knowledge on top of their subject matter expertise, need to be aware of learning design, online moderation and facilitation and to have good time management skills, attributes that are also congruent with some of the current literature on the subject (Garrison & Vaughan, 2008; MacDonald, 2008; Palloff & Pratt, 2007; Salmon, 2003 & 2011).

Furthermore, evidence from this research indicates that lecturers need to be digitally literate, have a conceptual understanding of the tools they are using and make the conceptual shift from content creation to interactive online facilitation. According to research participants, depending on the subject of the blended or fully online courses, they are often founded around constructivism and social constructivism, or problem-based learning and portfolio evidence. However, there are still some courses that follow a ‘pragmatic’ approach without an explicit learning theory or model behind their design. This, according to some research participants, seems to be an issue not exclusively related to blended and online courses as the lack of pedagogical underpinning could be evident in campus-based courses too, but as blended/online courses are mostly recorded on the web, it becomes more apparent in those.

Some HeLs participating in the research are in favour of online collaborative learning, while they perceive that many academic staff are still following the old instructional paradigm which focuses on content delivery and when they move to online environments, they tend to replicate that.

3.4 Perceptions on the quality of online learning

In terms of whether online learning was still seen as second best, there was a distinction between blended and online learning; while the use of technology in a blended way was seen as part and parcel of the student experience and as an extension of their learning rather than second best, purely online learning was sometimes seen as second best by academic staff. This, however, was attributed to a lack of understanding of the affordances of various technologies by those who made such claims and was reportedly beginning to change.
3.5 Online learning and its perceived impact on the teaching profession

In terms of online learning being accused of de-skilling the teaching profession leading to an ‘automated’ education with the aim to cut costs, this was reportedly not a strong argument any longer; it was only claimed to be shared by senior academic staff who feel threatened by the introduction of new technologies and based on the misconception that technology would replace lecturing staff. Most participants in the research argued that this model of ‘automated’ education would not work in HE, claiming that online learning is very skilful, time consuming and challenging and can lead to improved quality standards.

3.6 The thorny issue of cost of online learning

In terms of the pure cost of the online courses compared to their campus-based equivalents it seems that there is still a lot to be learned; according to research participants, it is very hard to generalise on the most expensive way of delivery as in most cases institutions do not follow a specific model due to the fact that their purely online provision is not very substantial. Furthermore, it appears that there are so many hidden costs involved in course delivery of both campus-based and online courses that complicate costs further. The only safe conclusion regarding this matter would be that online courses are more front-loaded as the course needs to be fully developed before it runs for the first time and that online courses are in no way a cheaper version of their face-to-face counterparts.

4 Conclusion – Recommendations

This study aimed to shed more light on the staff development activities currently on offer by HEIs in the UK in order to encapsulate information on both technical and pedagogical training in the area of TEL, as well as uses of examples of good practice in the form of case studies and CPD activities offered to academic staff in this area. The staff development needs of academic staff were positioned within the wider Higher Education context as TEL’s successful implementation requires a coordinated institutional approach.

Most universities represented in the survey offered a wide variety of staff development sessions/events for their academic staff that covers a range of digital skills as well as pedagogical considerations of various learning technologies; this includes hands-on training sessions, seminars on the pedagogically effective use of various learning technologies, online case studies, peer support via internal workshops/ conferences and, in some cases, other CPD activities in the area of TEL such as e-moderating online short courses, Staff Educational Development Association (SEDA) certified e-facilitation courses and postgraduate modules. Staff development opportunities around various learning technologies in UK HEIs may well be pervasive across the sector if the same pattern as indicated by this study occurs in all other universities; the perceived potential of technology to enhance the students’ experience in general and students’ learning in particular has led to the adoption of a wide range of approaches to staff development in this particular area. What is more, TEL is seemingly recognised as sound pedagogic practice as it is embedded in the PGCERT/PGCAP course either as a module of study or as an integral part of the course.

It became evident from this research that HEls state that effective online moderation and facilitation requires an explicit pedagogical understanding, the ability to structure online activities with clear objectives and specified assessment criteria. The tutors’ online presence is very important so that students are guided through the online environment; furthermore, students need to be supported online from induction to completion and their progress should be monitored. Therefore, teaching staff need to dedicate appropriate time to the online environment. The facilitation of discursive/dialogic learning requires a pedagogical understanding of constructivism and social constructivism and the lecturers involved should ideally have some experience of online moderation and facilitation in order to be able to support their students effectively online. On the other hand, experiential learning with technology can be resource heavy and specialist support staff are often needed to create the bespoke environment and the resources. Blended and fully online courses require more systematic use of TEL by their very nature and an explicit curriculum design. Learning theories and online pedagogies would be better taught in seminars and in the PGCert/PGCAP course which is compulsory for all new lecturers in HE.

Regarding the tools used, a certain level of competence and confidence with the technology is needed as is a conceptual understanding of the tools they might use; tutors need to develop some digital skills in order to be able to use the institutional platforms such as the VLE and its various tools, the e-portfolio system and the
Turnitin system for plagiarism prevention and detection. Basic HTML skills in order for them to be able to work with text, links, images and videos are always useful. Knowledge of Web 2.0 tools such as blogs, wikis and forums are also critical as they can enhance students’ learning through reflection, co-operation and collaboration. These skills, coupled with an ability to use e-assessment and e-feedback tools can empower tutors of the digital age to enhance the student experience. These skills can be acquired in a number of ways, such as training sessions, workshops, case studies, peer support and other CPD activities offered by most HE institutions. As pointed out by some HEs, although knowing how to use the VLE and basic ICT literacy are important, there is an overlap between the pedagogical knowledge and digital skills required for using TEL effectively.

It became apparent that TEL’s successful implementation by HEIs requires a coordinated institutional approach and a long-term investment; while there is evidence that TEL becomes part and parcel of the teaching and learning practice, it still takes time and effort and this conflicts with other aspects of university practice such as research, face-to-face teaching and student support as well as other administrative tasks that often overload the lecturers’ schedule. What is often lacking is a top-down approach to TEL-support implementation and a vision from senior management on ways TEL support can enhance and transform the student experience, according to some HEs. This is critically important as it can rationalise an institution’s approach to TEL support and make TEL’s adoption consistent and widespread, avoiding existing contradictions, such as lack of incentives for TEL adoption, lack of time allowance and other rewards for embedding TEL in the curriculum.

A coordinated institutional approach would therefore require strategic buy-in from senior management and a vision around TEL, opportunities for staff development and incentives to teaching staff to develop themselves in this area and utilise TEL more in their teaching. These incentives may include some time allocation as lack of time is the most common reason behind staff’s reluctance towards implementing TEL. Furthermore, for sustainable delivery of heavily blended and distance learning courses, costing models need to be looked at by the institution. Costing models need to include fixed and varied costs that are dependent on the discipline, delivery approach and resultant staff time required, but also on whether bespoke content needs to be developed or not. It became apparent from this research that more needs to be done in order to understand the real costs of online learning and that this is crucial for its sustainability.

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Does the Web Contain Pedagogically Informed Materials? The COSREW Outcomes

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Abstract: Web resources allow a learner to have more opportunities for study at any time and any place. It is still difficult, however, for learners to choose the right study materials to match their desired learning. A competence-based system for recommending study materials from the Web (COSREW) is proposed, based on the learner’s competences. COSREW generates a list of learning paths, and extracts search terms from the competence statements on the chosen learning path. Three experiments were conducted to evaluate COSREW’s recommendations. The first explored the differences between search engines and the qualities of the study material links in helping learners achieve their competences. The second experiment explored the differences between search keywords, and the third experiment compared COSREW with freely-browsing learning modes. The results showed that the Web is currently not a good resource for a pedagogically informed competence-based system, since Web pages predominantly comprise text-based subject matter content with little support for learning competence or capability.

Keywords: Competency Model; Competence Structure; Web-based Learning; Internet Supported Learning; Pedagogy; Self-learning

1 Introduction

The aim of this paper is to propose a competence-based system for recommending study materials from the Web (COSREW) which provides links as appropriate study materials. The main objective of COSREW is to help learners find study materials from the Web as supplementary resources outside the classroom. The Web can be an effective learning resource since it seems to offer diverse learning materials which could address learner needs. COSREW is based upon the COMBA competency model (Sitthisak et al. 2008), where a competence is conceptualised as consisting of three major components: subject matter, capability, and context. Within COSREW, the learner’s existing and desired competences lead to a selection of different learning paths. Keywords are extracted from the competence statements on the chosen learning path, and the resulting links are presented to the learner as recommendations. COSREW deploys an XML-schema which provides a common framework for abstracting the information in a competence structure. It can be reused for any knowledge domains of subject matter content.

In the following sections, the major literature on competency models and competence structures is presented, followed by the COSREW design. Later, a method of implementing a competence structure and its XML-schema is proposed. Next, three experimental studies which evaluated COSREW’s recommendations are presented and the results discussed. Finally, conclusions and further studies are addressed.

2 Competency Model and Competence Structure

This section introduces a competency model based on intended learning outcomes and discusses examples of existing competency models.

2.1 Definition of Competency

There are many definitions of competency in the literature. According to Smith (1996), ‘competency’ refers to the ability to do a particular activity to a prescribed standard. A definition of competency is given by the HR-XML consortium (HR-XML 2004):

ISSN 1479-4403 ©ACPIL
“specific, identifiable, definable, and measurable knowledge, skill, ability and/or other deployment-related characteristic (e.g. attitude, behaviour, physical ability) which a human resource may possess and which is necessary for, or material to, the performance of an activity within a specific business context.”

Another definition is given by McClelland (1973), “competency can be the knowledge, skills, traits, attitudes, self-concepts, values, or motives related to job performance or important life outcomes.” Friesen and Anderson (2004) define a competency as “the integrated application of knowledge, skills, values, experience, contacts, external knowledge resources and tools to solve a problem, to perform an activity or to handle a situation.” Finally, Cheetham and Chivers (2005) suggest the following general definition of competency: “effective overall performance within an occupation, which may range from the basic level of proficiency through the highest levels of excellence.”

2.2 Existing Competency Models and Structures

There are two existing international competency standards, IMS RDCEO (IMS RDCEO 2002) and HR-XML (HR-XML 2004). Their data models or schemas are minimalist but extensible.

IMS RDCEO provides five elements in its information model: identifier, title, description, definition and metadata. There are some disadvantages to this competency model, however, such as the oversimplification of the concept of competency, and the lack of provision for an adequate semantic level to support intelligent decisions. In particular, the model does not take into consideration explicitly important elements such as the knowledge and skills of learners (Baldiris et al. 2007), nor does it support a common language of competency.

HR-XML consortium’s competency schema has nine components: name, description, required, competency Id, Taxonomy Id, Competency Evidence, Competency Weight, Competency, and user Area. HR-XML competency can refer to knowledge, skill, ability, attitude, behaviour, or a physical ability. In terms of its implementation, it aims to be used by different people within different disciplines such as human resources management, industrial psychology, and education.

Sampson and Fytros (2008) identify some drawbacks to these competency standards, such as the titles and descriptor elements in these models not being directly machine understandable. Moreover, both standards adopt a competence description but do not take a proficiency level into consideration, although this is important to the competency concept (Sampson and Fytros 2008). Their proposed competency model is shown in Figure 1.

![Figure 1: Competency Model Elements (Sampson and Fytros 2008)](image)

The proficiency level in this competency model refers to skills, knowledge, and attitudes, but it remains inadequate. Proficiency can refer to either skills or knowledge in the model, but this is incompatible with considering an intended learning outcome as the combination of capability (skill) and subject matter (knowledge).

The competence structure specifies the range of competence elements/nodes for a particular knowledge domain and highlights the relationship between competence nodes. There are some existing competence structures which were designed from different aspects of competence. One competence structure was
developed by Kickmeier-Rust et al. (2006) as shown in Figure 2. One node represents a competence state which is a set of all available competencies of a person. The prerequisite relationships are defined within this set of competencies. Each competency in a state represents a problem or subject matter which a learner is required to solve.

Figure 2: Competence Structure Established by the Prerequisite Function (Kickmeier-Rust et al. 2006)

Another competence structure was proposed by Heller et al. (2006). However, this structure represents a competence-based knowledge structure. It is extended from a knowledge structure as is shown in Figure 3. They introduced two other sets of learning objects (LOs) and related skills for solving problems corresponding to each node within the structure. Nonetheless, this structure is based on knowledge representation.

Figure 3: Overview of Knowledge Structure of Domain Q = ‘a, b, c, d, e’ (Heller et al. 2006)

2.3 COMBA model

The proposed model for this research draws on the multidimensional competency model (called COMBA) proposed by Sitthisak et al. (2008). This considers the learners’ learnt capability instead of their knowledge level and views competences and learnt capabilities as a multidimensional space (Sitthisak et al. 2008). The COMBA model (Figure 4) consists of three major components: subject matter, capability, and context.
The competence structure, which is designed based on the COMBA model, contains nodes comprising capability, subject matter, and context (optional). There are some existing competence structures based on COMBA model. One sample is a tree of nursing competencies from the UK Royal College of Nursing introduced by Sitthisak et al (2009). The general form of this competence structure is shown in Figure 5. The relationship between nodes is parent-child with no ordering on the same level. A parent-child relationship identifies what the learner must be able to do (child) before something else (parent) can be learned.

Another competence structure was developed by Iskandar et al. (2010). This competence structure is shown in Figure 6. The competence nodes in this structure are all intended learning outcomes independent of context. This structure is based on the sport of rowing in the motor skill domain. The relationship between the competence nodes is parent-child (as in the previous competence structure example).

This section describes the application of the COMBA model to the COSREW design, and presents the system process of suggesting study materials from the Web.
3.1 Apply the COMBA Competency Model

There are some reasons why a COMBA competency model should be considered in this study.

First is the issue of a machine-processable, sharable, and modifiable representation of learner competence. Each individual learner’s competences are clearly defined with a competency model. A learner’s competences are connected to prerequisite or enabling competences and are formed as a network structure.

Second is the navigation of a competence structure or network. Navigating the structure offers various routes for providing learners with study material links to enable them to achieve a learning outcome.

The third issue is identifying the context of a learner’s competence. Learners may have differing levels of proficiency in relation to a given intended learning outcome, depending upon the context. The defined context of a competence distinguishes a competence from an intended learning outcome.

The fourth issue is that the COMBA model formally defines the combination of ‘capability’ and ‘subject matter’ as ‘intended learning outcome’. Intended learning outcomes describe what learners need to be able to do to complete a course satisfactorily (Macdonald 1999). An intended learning outcome (previously also known as an educational objective) has long been a central component in the design and structure of educational and training systems, particularly in schools and in industrial training (Reigeluth 1999, Gagne et al. 2004). In addition, an intended learning outcome provides a clear expectation on the part of the student which is a crucial part of their effective learning (Ramsden 1992).

3.2 COSREW Processes

The overview of the process within COSREW, illustrated at Figure 7, shows how COSREW deals with learners’ competences and how it recommends appropriate study material links from the Web to learners so that learners can achieve their intended learning outcomes.

First, a sub-process constructs a learner’s competence structure so that COSREW can generate lists of targeted subject matter and competences for learners to choose from. After the chosen subject matter and competences (desired and existing) are obtained, COSREW then generates a list of learning paths. COSREW constructs a search based on the chosen learning paths, and then suggests the resulting links to learners.

The reason for considering competence statements as the source of keywords for a search engine is explained as follows. Designing a system that will enable a learner to find appropriate study materials from the Web without any interaction from a teacher requires a method of obtaining information on the Web. Gordon and Pathak (1999) discussed four different methods for locating information on the Web:

- Go directly to a webpage location.
- Hypertext links emanating from a webpage provide built-in associations to other pages.
- Narrowcast services can push pages that meet particular user profiles.
- Use search engines to find and then furnish information on the Web that hopefully relates to that description.

As the learner’s competences are the information (input) that the system obtains from the learners, so the system should recommend study materials based on these competences. The appropriate method is to use queries to a search engine based on the desired competences. There are many search engines, for example, Google, Bing, Yahoo, Alta Vista and Microsoft. The type of search engine is not considered as an important point in this research: the search engine is used merely as the intermediate tool to get relevant study materials, using the learners’ competences.
4 Design of Competence Structure

This section begins with a procedure for designing a competence structure from an existing course syllabus. The XML-schema of the resulting competence structure is then presented which may be useful for construction, implementation, and evaluation, especially for those approaches which require the advantages of usability, semantics, and modifiability.

4.1 Method of designing a Competence Structure

In order to design a structure of competence information on the intended learning outcomes for the specific subject matter content of a course, the topic, syllabus, or curriculum is required. The subject matter content is categorised and tagged with relevant learner capabilities and contexts in order to derive the structure of competences.

4.1.1 Step 1: Choose the topic

Intended learning outcomes in UK education are published by, for example, AQA, OCR, and Edexcel. In this research, the intended learning outcomes from the course specification for photosynthesis at a Key Stage 4 (GCSE, UK) from AQA (revised version), (The Assessment and Qualifications Alliance 2010) were chosen for constructing the competence structure. Examples of intended learning outcomes from this specification are as follows:

- recall photosynthesis equation
- recall photosynthesis definition
- define chlorophyll
- interpret data showing how factors affect the rate of photosynthesis
- demonstrate a photosynthesis procedure
- predict the rate of photosynthesis in different conditions using computer simulations

4.1.2 Step 2: Task Analysis of Subject Matter

Next, the subject matter is extracted from all the intended learning outcomes and categorized into the four types of content following Merrill’s CDT (Component Display Theory) analysis (Merrill 1994). They are: fact, concept, procedure and principles. A specific technical definition of each category is provided in (Gilbert and Gale 2008).

Table 1: Definition of CDT Categories of Subject Matter (Gilbert and Gale 2008)

<table>
<thead>
<tr>
<th>CDT Categories</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact</td>
<td>Fact pair</td>
</tr>
</tbody>
</table>
| Concept        | Name of concept  
                  Superordinate concept class  
                  Attribute–value pairs that classify objects |
| Procedure      | Name of procedure  
                  used in situation  
                  to achieve a goal  
                  via a set of steps  
                  using tools |
| Principle      | Name of principle  
                  applied in situation  
                  involves cause-effect relationships between objects or events |

For photosynthesis at Key Stage 4, the list of subject matter and their CDT categorizations are provided in Table 2.
Table 2: Subject Matter Content and Categorization of Photosynthesis for Key Stage 4 Learners

<table>
<thead>
<tr>
<th>CDT Subject Matter Category</th>
<th>Subject Matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact</td>
<td>Photosynthesis equation, photosynthesis definition, substance, energy, sun, bulb, gas, CO$_2$, H$_2$O, O$_2$, plant cell, location, mesophyll cell, etc.</td>
</tr>
<tr>
<td>Concept</td>
<td>Chlorophyll, light, carbon dioxide, water, oxygen, chloroplast, etc.</td>
</tr>
<tr>
<td>Procedure</td>
<td>Photosynthesis procedure</td>
</tr>
<tr>
<td>Principle</td>
<td>Photosynthesis rate</td>
</tr>
</tbody>
</table>

Task analysis in instructional design is a process of analyzing and expressing the nature of learning content so that a learner knows how to perform (knows what to do) (Jonassen et al. 1998). The intention is to represent the subject matter content in the form of a diagram which is based on CDT categories. The CDT category “fact” comprises two elements, making a ‘fact pair’. Notationally, each element can be represented by a circle. For example, the fact, ‘Chemical formula of Carbon Dioxide is CO$_2$’ is represented by a fact pair, ‘chemical formula’ and ‘CO$_2$’ as shown in Figure 8.

**Figure 8: Task Analysis of Fact ‘Chemical formula of Carbon Dioxide is CO$_2$’**

The CDT category “concept” involves the concept name and its super ordinate class, which is normally a fact pair. The relationship between class and super ordinate class is ‘is a kind of’. Notationally, a concept may be represented by a triangle. A concept comprises a number of attribute-value pairs which distinguish the concept from other similar concepts. For example, the concept of carbon dioxide is shown in Figure 9.

**Figure 9: Task Analysis of the Concept of Carbon Dioxide**

The CDT category “procedure” consists of a set of steps. Notationally, each step may be represented by a square. For example, the photosynthesis procedure is shown in Figure 10.
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Figure 10: Task Analysis of the Photosynthesis Procedure

The CDT category “principle” involves causes and their effects. Notationally, the principle itself may be represented by a pentagon. For example, the principle of photosynthesis rate is shown in Figure 11. Causes are shown on the left side of the pentagon and the right side shows the effects or results.

Figure 11: Task Analysis of the Principle of Photosynthesis Rate

4.1.3 Step 3: Decompose Levels of Task Analyses

Step 3 comprises of 3 sub steps as follows:

- **Sub-Step 1 (Construct Level 0):** Identify the topic of the whole subject or syllabus. For example, level 0 contains one subject matter as ‘photosynthesis’.

- **Sub-Step 2 (Construct Level 1):** From the course specification structure and its top level statements, identify the subject matter which comprises the level 0 topic. For example, from the AQA Key Stage 4 course specification, level 1 comprises four subject matters as ‘photosynthesis definition’, ‘photosynthesis equation’, ‘photosynthesis procedure’, and ‘photosynthesis rate’.

- **Sub-Step 3 (Construct Level i+1):** Consider each of the subject matters identified in level i. For any concepts, procedures, or principles, place their constituent elements (which may be facts or further concepts, procedures, and principles) at this level i+1. These constituent elements are those as found in sub-step 2. If there are no such subject matters, then END. Otherwise, repeat this sub-step 3 for level i+2.

4.1.4 Step 4: Structure Subject Matter Relationships

Assign a parent-child relationship between subject matter nodes as follows:

- **Sub-Step 1:** The level 0 subject matter is the parent of level 1 subject matter.

- **Sub-Step 2:** Each level i+1 subject matter is the parent of its level i+2 constituent elements.

For example, the resulting structure of the Key Stage 4 photosynthesis subject matter is illustrated in Figure 12.
4.1.5 Step 5: Tag Each Node with Capability and Context

In order to develop a competence structure, each node of subject matter requires tagging with a corresponding capability and a context. These tags are taken from the course specification. For example, the resulting competence structure of photosynthesis for Key Stage 4 learners is shown in Figure13.

The competence structure is represented as a tree structure and the relationships between nodes are represented as parent-child relationships. This method of designing a competence structure allows developers to design the competence structures they may need from existing course specifications, curricula, and syllabi.
Figure 12: Knowledge Structure of Photosynthesis for Key Stage 4 Learners
Figure 13: Competence Structure of Photosynthesis for Key Stage 4 Learners Domain Mapped XML-Schema
The XML format for representing a competence structure is now illustrated. XML enables a focus upon the definition of shared vocabularies for exchanging information, supporting the reuse of the content in other applications (St. Laurent 1998). In this section, the derivation of the XML schema is described, based upon an entity relationship diagram.

### 4.1.6 Entity Relationship Diagram Representing Competence Structure

The entity relationship diagram (ERD) of Figure 14 generally represents all the data entities and attributes in any competence structure, including intended learning outcomes, different types of subject matter content (including their task analyses), and contexts.

**Figure 14:** ER Diagram of Competence Structure

### 4.1.7 Mapping XML-Schema

An XML-Schema defines the terms, relationships, and constraints required to support communication in a particular application domain (Carlson 2001). All schemas provide some degree of definition and documentation for an XML vocabulary. For a competence-based system, an XML-schema represents a common framework for abstracting the required information. Figure 15 illustrates an XML-schema for a competence structure. This schema is the ER diagram of section 4.2.2 represented in XML.
5 Experiment One

In this experiment, the search results given by the Google browser (www.google.com) were compared to those given by the API to Google, in terms of user ratings of achievement. The Google API is the mechanism by which COSREW carries out a search.

In general, the Google browser tends to weight the search results based upon the user’s browsing activities, but this information is not employed by the Google API (Kilgarriff 2007). Hence, the results from their searches can be different.

5.1 Experimental Methodology

The research question of experiment one concerned the users’ reactions (Kirkpatrick 2007) and required expert review. The topic was photosynthesis for Key Stage 4 learners. Four competence nodes were used, representing a range of competence types on Bloom’s taxonomy from ‘recall’ to ‘predict’, as follows:

- Recall a photosynthesis equation
- Demonstrate a daytime photosynthesis procedure
- Predict a photosynthesis rate
- Define chlorophyll

Keywords (combination of capability, subject matter, and context) were generated for each of the nodes. For example, the node “Predict a photosynthesis rate” yielded the keywords “predict”, “photosynthesis”, and “rate”. These keywords were submitted to Google (www.google.com) on the one hand, and to the Google API on the other. The first three resulting links were presented to the participant, who rated them.

The estimated number of participants required was obtained using G*Power software (Buchner et al. 2010) which was designed as a general stand-alone power analysis program for statistical tests commonly used in social and behavioural research (Faul et al. 2007). The number of participants required in each experiment differed according to the nature of the experiment. The required sample size (i.e., the required number of links) of this experiment was 24 according to G*power, using an effect size f = 1, an alpha error probability = 0.05, power = 0.8, the test family as F-test, the number of groups = 2, and the statistical test as ANOVA fixed effects.
5.2 Questionnaire Analysis

The participant gave a rating of ‘helpfulness to achieve learning outcome’ to each link on a scale of six (1, 2, 3, 4, 5, and 6). The 6-point Likert scale was adopted in order to avoid a neutral or mid-point, resulting in a ‘forced choice’. Eliminating the mid-point category from the Likert scale reduces social desirability bias (Garland 1991). Chen, Lee, & Stevenson (1995) and Stening & Everett (1984) found that Asian participants were more likely to choose the midpoint of Likert scale item than Americans. The use of forced choice in the Likert scale, as is common in opinion research, was considered appropriate given the Thai participants in the experiment.

In this experiment, the participant was obliged to rate the links as either non-useful (1-3) or useful (4-6). The scales were:
- This website is not related to any materials required in order to learn how to achieve a competence
- This website gives little information required in order to learn how to achieve a competence
- This website gives some information required in order to learn how to achieve a competence
- This website gives useful information required in order to learn how to achieve a competence
- This website gives very useful information required in order to learn how to achieve a competence
- This website gives, not only the very useful information required in order to learn how to achieve a competence, but also with systematic feedback

5.3 Experimental Results

A two-way ANOVA was used to analyse the obtained data in order to find any significant differences between mean ratings of the search engine types and competence node types. ‘Search Engine_Type’ comprised two levels: Google and Google API. ‘Competence_Node’ type comprised four levels: ‘Recall a photosynthesis equation’, ‘Demonstrate a day time photosynthesis procedure’, ‘Predict a photosynthesis rate’, and ‘Define chlorophyll’.

Table 3 and Table 4 show the descriptive statistics, and tests of between-subjects effects respectively.

### Table 3: Means and Standard Deviations of Ratings of Links (Google VS. GoogleAPI)

<table>
<thead>
<tr>
<th>SearchEngine_Type</th>
<th>Competence_Node</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google</td>
<td>Recall a photosynthesis equation</td>
<td>4.0</td>
<td>2.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>2.3</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>1.0</td>
<td>0.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>1.3</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2.2</td>
<td>1.39</td>
<td>12</td>
</tr>
<tr>
<td>GoogleAPI</td>
<td>Recall a photosynthesis equation</td>
<td>4.3</td>
<td>1.53</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>2.3</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>1.0</td>
<td>0.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>1.3</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2.3</td>
<td>1.55</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>Recall a photosynthesis equation</td>
<td>4.2</td>
<td>1.60</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>2.3</td>
<td>0.52</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>1.0</td>
<td>0.00</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>1.3</td>
<td>0.52</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2.2</td>
<td>1.50</td>
<td>24</td>
</tr>
</tbody>
</table>

### Table 4: Tests of Between-Subjects Effects (Google vs GoogleAPI)

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SearchEngine_Type</td>
<td>0.04</td>
<td>1</td>
<td>0.04</td>
<td>0.04</td>
<td>0.837</td>
</tr>
<tr>
<td>Competence_Node</td>
<td>36.46</td>
<td>3</td>
<td>12.15</td>
<td>12.68</td>
<td>0.000</td>
</tr>
<tr>
<td>SearchEngine_Type * Competence_Node</td>
<td>0.13</td>
<td>3</td>
<td>0.04</td>
<td>0.04</td>
<td>0.987</td>
</tr>
<tr>
<td>Error</td>
<td>15.33</td>
<td>16</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>169.00</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The data obtained (as shown in Table 3) gave the statistical results (Table 4) as follows.
1. There was no significant interaction effect between type of search engine and type of competence node (0.05< p = 0.987).
2. There was no significant main effect for type of search engine. This indicates that there was no significant difference between the means of ratings of links generated from Google and GoogleAPI (0.05< p = 0.837)
3. There was a significant main effect for type of competence node. This indicates that there were significant differences among mean ratings of links based on different types of competence node (p <0.05).

6 Experiment Two

Experiment two was conducted to explore whether the search results for competence keywords were better than those for subject keywords in terms of learner achievement of the competence concerned. The research question was whether the Web links from competence keywords were likely to be more helpful for a learner than those from subject keywords.

6.1 Experimental Methodology

The methodology was similar to experiment one. While experiment one considered ‘types of search engine’, experiment two considered ‘types of keywords’. There were two types of keywords: subject (only subject matter) and competence (combination of capability, subject matter, and context).

6.2 Questionnaire Analysis

The questionnaire was similar to experiment one (see section 6.2), where the participant gave a rating of ‘helpfulness to achieve learning outcome’ to each link.

6.3 Experimental Results

A two-way ANOVA was used to analyse the obtained data in order to find any significant differences between mean ratings of the keywords types and competence node types. ‘Keyword_Type’ comprised two levels: subject and competence. ‘Competence_Node’ comprised four levels: ‘Recall a photosynthesis equation’, ‘Demonstrate a daytime photosynthesis procedure’, ‘Predict a photosynthesis rate’ and ‘Define chlorophyll’. Table 5 and Table 6 show descriptive statistics and the tests of between-subjects effects respectively.

Table 5: Means and Standard Deviations of Ratings of Links (Subject vs Competence)

<table>
<thead>
<tr>
<th>Keyword_Type</th>
<th>Competence_Node</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>Recall a photosynthesis equation</td>
<td>5.0</td>
<td>0.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>2.3</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>4.7</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>4.7</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.2</td>
<td>1.19</td>
<td>12</td>
</tr>
<tr>
<td>Competence</td>
<td>Recall a photosynthesis equation</td>
<td>4.7</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>1.7</td>
<td>0.58</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>5.0</td>
<td>0.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>5.0</td>
<td>0.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.1</td>
<td>1.50</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>Recall a photosynthesis equation</td>
<td>4.8</td>
<td>0.41</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Demonstrate a day time photosynthesis procedure</td>
<td>2.0</td>
<td>0.63</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Predict a photosynthesis rate</td>
<td>4.8</td>
<td>0.41</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Define chlorophyll</td>
<td>4.8</td>
<td>0.41</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.1</td>
<td>1.33</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 6: Tests of Between-Subjects Effects (Subject vs Competence)

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyword_Type</td>
<td>0.42</td>
<td>1</td>
<td>0.42</td>
<td>0.20</td>
<td>0.661</td>
</tr>
<tr>
<td>Competence_Node</td>
<td>36.13</td>
<td>3</td>
<td>12.04</td>
<td>57.80</td>
<td>0.000</td>
</tr>
<tr>
<td>Keyword_Type * Competence_Node</td>
<td>1.13</td>
<td>3</td>
<td>0.38</td>
<td>1.80</td>
<td>0.188</td>
</tr>
<tr>
<td>Error</td>
<td>3.33</td>
<td>16</td>
<td>0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>449.00</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data obtained (as shown in Table 5) gave the statistical results (Table 6) as follows.

1. There was no significant interaction effect between types of keywords and types of competence node (0.05 < p = 0.188).
2. There was no significant main effect for types of keywords. This indicates that there was no significant difference between the means of ratings of links generated from subject and competence keywords (0.05 < p = 0.661).
3. There was a significant main effect for types of competence node. This indicates that there were significant differences among mean ratings of links based on different types of competence node (p < 0.05).

7 Experiment Three

Experiment three was conducted to compare whether learning using COSREW was better than learning by freely browsing.

7.1 Experimental Methodology

The pictorial representations of both learning modes are shown in Figure 16 and Figure 17.

Figure 16: COSREW Learning Mode

Figure 17: Freely-browsing Learning Mode

In the COSREW learning mode, learners were given a set of subject matter to study, and they decided their own choice of competences. COSREW generated the keywords from the chosen competences and suggested links to learners. In the freely-browsing learning mode, learners were given the same set of subject matter to study, and were required to decide the keywords to be given to the Google search engine on their own.

The experiment was concerned with the second, ‘learning’, level of Kirkpatrick’s four levels of evaluation (Kirkpatrick 2007). The participants were assigned to one of two groups: one group experienced the COSREW learning mode and the other group experienced the freely-browsing learning mode. All participants were required to take a pre-test and a post-test, before and after experiencing the respective learning modes. The pre-test and post-test were the same for all participants, being a multiple choice test consisting of 10 questions. The scores obtained from the pre-test and post-test were compared for each learning mode.

The required sample size of this experiment was 6 according to G*power, using an effect size f = 1, an alpha error probability = 0.05, power = 0.8, the test family as F-test, the number of groups = 2, and the statistical test as ANOVA repeated measures, within-between interaction.

7.2 Questionnaire Analysis

The questions in the pre-test/post-test were based on selected subject matter of the Key Stage 4 photosynthesis competence structure (see Figure13). The chosen subject matter was as follows:
- Photosynthesis rate
- Photosynthesis procedure
- Chlorophyll
- Carbon dioxide, Oxygen, Water, Glucose
- Chloroplast

Table 7 shows some of the pre-test/post-test questions.
Table 7: Examples of Questions in Pre-test and Post-test (Experiment III)

<table>
<thead>
<tr>
<th>Subject Matter Content</th>
<th>Questions in Pre-Test/Post-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthesis rate</td>
<td>Which factor does not affect the rate of photosynthesis?</td>
</tr>
<tr>
<td>Photosynthesis procedure</td>
<td>What are the products of photosynthesis?</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>Which cells in leaf contain chlorophyll?</td>
</tr>
<tr>
<td>Carbon dioxide, Oxygen, Water, Glucose</td>
<td>Which chemical formulas represent carbon dioxide, oxygen, water and glucose respectively?</td>
</tr>
<tr>
<td>Chloroplast</td>
<td>A key molecule NOT found in a chloroplast is ...</td>
</tr>
</tbody>
</table>

7.3 Experimental Results

Two-way repeated measures ANOVA was used to analyze the obtained test scores, in order to determine the better learning mode. ‘Learning mode’ comprised two levels, freely-browsing and COSREW. ‘Test type’ comprised two levels, pre-test and post-test.

Table 8, Table 9, and Table 10 show the descriptive statistics, the tests of within-subjects effects and the tests of between-subjects effects. Figure 18 displays the profile graphs.

Table 8: Mean and Standard Deviation of Test Scores

<table>
<thead>
<tr>
<th>Test_Type</th>
<th>Learning_Mode</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre_Test</td>
<td>Freely_Browsing</td>
<td>7.0</td>
<td>1.41</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>COSREW</td>
<td>4.5</td>
<td>1.29</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.8</td>
<td>1.83</td>
<td>8</td>
</tr>
<tr>
<td>Post_Test</td>
<td>Freely_Browsing</td>
<td>7.8</td>
<td>1.89</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>COSREW</td>
<td>6.3</td>
<td>1.26</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>7.0</td>
<td>1.69</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>Freely_Browsing</td>
<td>7.4</td>
<td>1.50</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>COSREW</td>
<td>5.4</td>
<td>1.41</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6.4</td>
<td>1.76</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 18: Profile Graph of Mean Ratings of Test Scores of Pre-Test and Post-Test for Two Learning Modes (Error Bars Show +/- 1SE)
Table 9: Tests of Within-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test_Type</td>
<td>6.25</td>
<td>1</td>
<td>6.25</td>
<td>4.84</td>
<td>0.07</td>
</tr>
<tr>
<td>Test_Type * Learning_Mode</td>
<td>1.00</td>
<td>1</td>
<td>1.00</td>
<td>0.77</td>
<td>0.41</td>
</tr>
<tr>
<td>Error</td>
<td>7.75</td>
<td>6</td>
<td>1.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning_Mode</td>
<td>16.00</td>
<td>1</td>
<td>16.00</td>
<td>5.12</td>
<td>0.06</td>
</tr>
<tr>
<td>Error</td>
<td>18.75</td>
<td>6</td>
<td>3.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data obtained (as shown in Table 8) gave the statistical results (Table 9 and Table 10) as follows.

- There was no significant interaction effect between test type and learning mode (0.05 < p = 0.41).
- Accepting alpha = 0.10 as a “suggestive” level of significance, there was a significant test type effect. The result suggested that there was a significant difference between the mean test scores between pre-test and post-test at a significance level of 0.10 (0.05 < p = 0.07 < 0.10). Inspection of the means in Table 8 shows that the post-test mean was significantly higher than the pre-test mean.
- Accepting alpha = 0.10 as a “suggestive” level of significance, there was a significant learning mode effect. The result suggested that there was a significant difference between the mean test scores between a freely-browsing learning mode and a COSREW learning mode (0.05 < p = 0.06 < 0.10). Inspection of the means in Table 8 shows that the mean of the freely-browsing learning mode was significantly higher than the mean of the COSREW learning mode.

The profile plot illustrates the interaction (Figure 18). The profile lines are apparently not parallel, visually suggesting an interaction, but this was not a statistically significant effect.

8 Discussion

8.1 Experiment One

Experiment one sought to determine whether the search results given by the Google browser (www.google.com) were significantly better than those given by the Google API in terms of their rating of ‘helpfulness to achieve learning outcome’. The means ratings of links between the two types of search engine did not differ according to type of competence node; the two types of search engine gave similar results. This suggests that future development of search-based learning materials does not need to be concerned about any differences in the resulting links between the search engine itself or the provided API.

8.2 Experiment Two

Experiment two sought to determine whether the search result ratings of ‘helpfulness to achieve learning outcome’ for competence keywords were significantly better than those for subject keywords. The mean ratings of links for the two types of keywords did not differ according to type of competence node; the two types of keywords gave similar results. While it is commonly thought that the Web is a sufficient resource for learning and learners, it was expected that the Web would support the competence keywords for better results. The obtained results, however, showed no significant differences between the two types of keyword. All the generated links from both subject and competence keywords were reviewed and it was confirmed that they mostly contained subject matter explanation, with little capability and context elements. It seems that the Web does not, in general, provide pedagogically-informed learning materials. It may be that future work should explore the value of video in sites such as YouTube\(^1\), Yahoo! Video\(^2\), and Flickr\(^3\) since such video

\(^1\)http://www.youtube.com/
\(^2\)http://screen.yahoo.com/
\(^3\)http://www.flickr.com/explore/video/
resources are involved in many current learning systems, for example, MOOCs (Pappano 2012, Kay et al. 2013). Choi and Johnson (2005) concluded that context-based videos in online courses have the potential to enhance learners' retention and motivation better than traditional text-based instruction. Hence video resources can be another domain to explore.

8.3 Experiment Three

Experiment three explored whether a COSREW learning mode was better than a freely-browsing learning mode, where it was expected that learners would achieve higher test scores in the COSREW learning mode, as illustrated in Figure 19. In such an experiment, ideally the pre-test scores for the two groups should be equal; in other words, the participants in the two groups should have equal initial knowledge.

![Image](https://example.com/image.png)

**Figure 19:** Expected Results of Profile Graph of Mean Ratings of Test Scores of Pre-Test and Post-Test for Two Learning Modes (Error Bars Show +/- 1SE)

Significant improvements were shown in both modes of learning. Participants in the freely-browsing learning mode were initially more knowledgeable than those in the COSREW learning mode group. It could be that the learners’ existing knowledge helped them to improve their learning, leading to the finding of no significant interaction between learning mode and pre-test/post-test change. This also supports the view that the Web may not currently be pedagogically informed.

8.4 Generalisation of results

While the experiments involved one subject and one stage of education, their focus was on whether and how enhancing content keywords with competence capabilities might improve learning. In such a context, it would not be expected that the specifics of the subject (photosynthesis) and level of education (GCSE) would particularly prevent appropriate generalisation of the findings to other subjects and other educational levels.

9 Conclusions and Future Work

COSREW was proposed for suggesting study materials from the Web, deriving Web links from learners’ competences. A process for designing a competence structure and presenting its corresponding mapped XML-schema was also proposed. Three experiments were conducted. In experiment one, the search results generated by Google and by the Google API were equally good in terms of perceived ratings of learning outcome achievement. In experiment two, the search results generated from subject keywords and from competence keywords were equally good in terms of perceived ratings of learning outcome achievement. In experiment three, learners’ improvements were equal in both modes of learning (freely-browsing and COSREW). From experiment two and three, it may be concluded that the Web may not currently be a good
resource for learning or for a pedagogy-informed approach to learning, especially for COSREW. Most Web pages contain subject matter-based explanation and this may not be sufficient for learning where capability and context is important.

For future work, related video may better support the learning of certain competences and should be included in the COSREW system. Second, authors should be encouraged to provide competence metadata when constructing Web pages. Search engines may then find more pedagogically relevant Web pages when their capability and context metadata is identified. Third, Linked Data principles (Berners-Lee 2006) can be applied by setting the Linked Data set and related metadata as the required competence information. The resulting RDF links ensure all Web materials with the same data set and metadata are linked to each other, providing the desired pedagogically-informed support for competence-based Web resources. Fourth, context classification using the COMBA competency model can be explored further. The literature discusses various aspects of context yet this concept is still not well defined. De Jong (2007) specifies context as identity, location, time, environment, and relation. Sampson and Fytros (2008) define context as job, occupations, function, life outcome, situation, and task. Zimmermann, Lorenz and Oppermann (2007) classified context information into five categories: individuality, activity, location, time, and relations. A well-defined and standard definition of context is still needed. Fifth, a competence structure repository should be considered so that the structures can be stored, discovered, searched, and reused. Lastly, the outcomes of experiment three suggested that the learning improvement of learners in the freely-browsing mode was due to the higher initial knowledge of participants. In order to validate this suggestion, future work could include the study of the impact of knowledge on learners' learning when interacting with a freely-browsing learning mode. This is to explore the significant differences between the learning of knowledgeable learners and that of non-knowledgeable learners when interacting with a freely-browsing learning mode.

References


Learner Differences in Perceived Satisfaction of an Online Learning: an Extension to the Technology Acceptance Model in an Arabic Sample

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Abstract: Online learning constitutes the most popular distance-learning method, with flexibility, accessibility, visibility, manageability and availability as its core features. However, current research indicates that its efficacy is not consistent across all learners. This study aimed to modify and extend the factors of the Technology Acceptance Model (TAM) to examine perceived satisfaction of an Arabic sample in online learning. The integrated factors in the modified model includes: deep level (learning styles), surface level (gender), and cognitive (online self-efficacy) factors. Learning styles were chosen as a central factor. Hence, the online course was purposefully developed to support one pole in each dimension of Felder and Silverman Learning Styles Model (FSLSM) in order to reveal the pedagogical implications of learning styles on learner satisfaction. A total of 70 learners participated voluntarily in the research. At the end of the online course, they were requested to fill in two questionnaires: the Index of Learning Styles (ILS) and a standard questionnaire. The psychometric properties of the latter were firstly analysed to validate the instrument. Then, Partial Least Squares Structural Equation Modelling (PLS-SEM) was conducted to examine the proposed hypotheses. The model achieves an acceptable fit and explains 44.8% of variance. Perceived usefulness represented the best predictor, whereas online self-efficacy and perceived ease of use failed to show a direct impact on perceived satisfaction. Furthermore, neither learning styles nor gender diversity had direct influence on the dependent factors. Accordingly, the research suggested that other variables may have to be integrated to enhance the power of the model.

Keywords: online learning, learning styles, gender diversity, online self-efficacy, learner satisfaction, Technology Acceptance Model (TAM)

1 Introduction

The rapid development of digital technologies, and most prominently, e-learning, has revolutionised the methods of distance learning. In this vein, a definition of e-learning must first be established and perhaps the most widely-accepted definition is “the delivery of learning with the assistance of interactive, electronic technology, whether offline or online” as cited in Procter (2003). It is noteworthy that ‘e-learning’ and ‘online learning’ are not synonymous terminologies. For the purposes of this research, ‘e-learning’ is used as a general concept encompassing online learning as well.

Although the flexibility, accessibility, visibility, manageability, and availability of e-learning systems have helped to address some of the limitations of traditional learning, this does not mean that traditional methods are to be altogether replaced yet. The examination of e-learners responses to their online learning experience can shed some light on why this is so. According to Bouhnik & Marcus (2006), some common expressions of dissatisfaction are connected with the absence of a ‘learning atmosphere’, and the lack of direct, for example, face-to-face interaction between ‘learner-learner’ and ‘learner-instructor’. They also stated that in online learning settings, students believe that they do not get enough detail in response to their enquiries, and the needed time to learn a new topic is longer, when compared with apprehending a new topic in a traditional way.

Other personal and environmental factors that may lead to user dissatisfaction entail the absence of ‘self-motivation’, the difficulty of constructing new knowledge without direct guidance, and the lack of self-efficacy in the use of e-learning (Bouhnik & Marcus, 2006; Dutton, Dutton, & Perry, 2001). Such drawbacks are indicative of the reasons why some users withdraw from their online courses after their first experience or failure to pass it. Thus, in order to accept the conclusion of Sun, Tsai, Finger, Chen, & Yeh (2008) that e-learning is an alternative method to traditional learning, such issues have to be tackled.
Many models were proposed to examine factors that can help towards the prediction of user intention to accept technologies, or perceived satisfaction, for instance, the Theory of Planned Behaviour (TPB) (Ajzen, 1991), the Consumer Acceptance of Technology (CAT) model (Kulviwat, Bruner, Kumar, & Clark, 2007), the Integrated Conceptual Model (ICM) (Sun et al., 2008), and the Technology Acceptance Model (TAM) (Davis, 1986). According to literature, TAM represents one of the most commonly used models (Bogozzi, 2007; Tarhini, Hassouna, & Abbasi, 2015; Sun et al., 2008). Although it has been widely adopted, few studies have investigated its reliability and validity in developing countries (Tarhini et al., 2015; Teo, 2008). Furthermore, the model was designed for use with a general variety of technologies, and not a particular one.

In Iraq, the Higher Education system is considered the best in the Middle East and, more specifically, in the Arab Gulf region (Kaghed & Dezaye, 2009). However, it was isolated from the environment of scientific research due to the regime of Saddam Hussein and the sanctions imposed by the United Nations (Kaghed & Dezaye, 2009). Until the middle of 2003, Iraqi people did not have access to the internet because its public usage was forbidden by the authorities. After the second Gulf war, the Ministry of Higher Education and Scientific Research (MHESR-I) took serious steps to reconstruct Higher Education albeit in pertinence to the traditional education only; attempts for the adoption of e-learning have been limited. Many reasons can be accounted for this and the prevention of widespread use of online learning in Iraq such as the low internet bandwidth even in public educational institutions; the lack of experience of the internet and web-based learning; poverty and low income. Hence, the present study attempted to examine learner perspectives on this new experience in order to promote quality in learning. In this context, this is an unexplored area of research. Learning styles as a psychological factor were integrated in the course design as a core variable that may affect learner perceptions. Although more than 71 learning style models were proposed (Coffield, Moseley, Hall, & Ecclestone, 2004), the FSLSM (Felder & Silverman, 1988) was adopted in this research for several reasons. Firstly, it is the most dominant model in previous studies (Akbulut & Cardak, 2012; Al-Azawei & Badii, 2014). Moreover, it is suitable for Technology Enhanced Learning (TEL) (Graf, 2007; Viola, Graf, & Leo, 2006). Finally, the proposed instrument to diagnose this model was validated (Felder & Brent, 2005; Litzinger, Lee, Wise, & Felder, 2007; Zywno, 2003).

This research aimed to achieve two goals. First, it modified TAM in order to assess perceived satisfaction in online learning instead of attitude to use a technology by incorporating three individual variables of learners: deep level factor (learning styles), surface level factor (gender diversity), and cognitive factor (online self-efficacy). The central factor in this modification was learning styles because studies have not provided conclusive evidence either for or against their pedagogical impacts on perceived satisfaction, or whether mismatching teaching and learning styles can lead to learner dissatisfaction. Accordingly, the investigated learning environment was designed to serve one pole in each dimension of the FSLSM. Second, the study examined the soundness of the modified version of TAM in a developing country in order to contribute to the existing evidence regarding the appropriateness of the model in such learning environment. The rest of the research is structured as follows. In Section 2, the basic concepts are discussed. Section 3 identifies the main factors of the proposed model and hypotheses. Section 4 depicts the adopted methodology. The main findings are presented and discussed in Section 5. Subsequently, Section 6 highlights the implications and limitations of the research. Finally, Section 7 encapsulates the main themes of the study and the possible future work.

2 Basic Concepts

2.1 Online learning

Online learning has been classified into two categories: synchronous and asynchronous. In the former, learners and instructors are geographically separated, but work simultaneously; in the latter, learners and instructors are both geographically and timely separated. In this research, asynchronous category was adopted because it gives learners more flexibility to reflect on the course content and the issue of time zone was addressed. According to Solimeno, Mebane, Tomai, & Francescato (2008), online learning is very suitable for people who have problems of time-management or job-commitment nature. However, the benefits of online learning are subject to other variables of learners, teachers, and learning environments. Accordingly, the reasons underlying learner dissatisfaction have not been investigated out of these dimensions.

On the other hand, the core drawback in an asynchronous learning environment is the absence of direct face-to-face interaction. Sweeney, Ingram, & Swee (2001) compared face-to-face, synchronous, and asynchronous learning modes. From learners’ perspective, traditional tutorials were more preferable, effective, helpful, and satisfying, whereas chat room in synchronous tutorials was more enjoyable. Furthermore, whilst ethnicity
showed to affect learner perception of type of tutorial, gender and internet experience did not. Generally, all participants preferred face-to-face learning over the other two types.

2.2 The Technology Acceptance Model (TAM)

Davis (1986) proposed the Technology Acceptance Model (TAM) to predict the tendency of users to accept technologies. The model was originally developed to explain the behaviour of users towards computer-usage and Information Technology (IT). The main variables in this model are perceived usefulness (PU) and perceived ease of use (PEOU) which can influence users’ attitudes towards using a technology (ATU). This model is widely employed in order to assess the acceptance of a particular technology (Bogozzi, 2007; Tarhini et al., 2015). Investigating the integrated factors exhibited how they perfectly linked with user attitude and behavioural intention. Therefore, studies have adopted the model to reveal the acceptance of users towards, for example, e-mail, computer based learning, blended learning, Rich Site Summaries (RSS), and online learning (Gefen & Straub, 1997; Ong & Lai, 2006; Liu, Chen, Sun, Wible, & Kuo, 2010; Tarhini et al., 2015).

On the other hand, perceived usefulness and ease of use factors affecting learner satisfaction, appeared to be the most important parameters in studies aiming to find the causal relationship among different variables and perceived satisfaction (Arbaugh, 2000; Atkinson & Kydd, 1997; Drennan, Kennedy, Pisarski, & Taylor, 2011; Liaw, 2008; Sun et al., 2008). In theory, there is an axiomatic relationship among perceived usefulness, ease of use and satisfaction because compounding increased expectation of outcome improvement with less effort leads to higher level of satisfaction. Consequently, based on the positive results of literature such as these in Liaw (2008) and Sun et al. (2008), we investigated the causal link among these factors and learner satisfaction as the first change in the original TAM.

3 Theoretical Framework and Hypotheses

Although many factors can be incorporated to infer learner satisfaction, the notion that ‘simpler is better’ was adopted. Therefore, only learner characteristics were used to modify and extend TAM, so as to illustrate the role of such features, more specifically, learning styles. Davis (1986) examined the effect of perceived usefulness (PU) and ease of use (PEOU) with the intention to adopt a technology. The expectation that a particular technology would not assist to enhance performance or it require high mental effort may lead to users’ dissatisfaction. As such, we examined the value of PU and PEOU on perceived satisfaction (PS). However, individual differences should be considered because such features and psychological traits may affect learner satisfaction in online learning. Additionally, prior literature that used TAM as a research framework indicated the importance of extending the model to improve its power (Edmunds, Thorpe, & Conole, 2012; Legris, Ingham, & Collerette, 2003; Venkatesh & Davis, 2000); hence, another change in the TAM includes integrating learning styles (deep level factor), gender diversity (surface level factor), and online self-efficacy (OSE) (cognitive factor). Figure 1 depicts the proposed dimensions of the model.

![Figure 1: The proposed model](image-url)

3.1 Deep level factor (Learning styles)

Learning styles represent the main extension of this study as a deep level factor, with potential influences on perceived usefulness and satisfaction. Felder (1996) defined learning styles as the “characteristic strengths and
preferences in the ways they ‘learners’ take in and process information”. The hypothesis of learning styles suggests the importance of matching learning and teaching styles because this trait affects academic achievement, learning time, learning patterns and learner satisfaction (Brown, 2007; Graf, 2007; Klašnja-Miličević, Vesin, Ivanović, & Budimac, 2011; Popescu, 2010). Additionally, as Felder & Brent (2005) stated, neglecting learning styles results in learners to withdrawing from a course or underperforming. Respectively, there seems to be a correlation among these factors as learners will not accept a learning environment if their preferences are ignored. Based on this assumption, perceived usefulness and satisfaction regarding a particular learning technology may rely on the level of accommodating their styles. Contrary, some researchers have disputed the pedagogical implications of learning styles due to the absence of convincing evidence to support such value (Mayer, 2011; Pashler, McDaniel, Rohrer, & Bjork, 2008). According to Mayer (2011, p320),

Towards this end, this trait was integrated in the modified model by assuming that catering an online course in accordance with a particular style of learners may enhance their perceived usefulness and satisfaction. In the context of the TAM, we hypothesise that:

**H1a**: Learners’ learning styles positively affect perceived usefulness (PU) in online learning.

**H1b**: Learners’ learning styles positively affect perceived satisfaction (PS) in online learning.

### 3.2 Surface level factor (Gender diversity)

Many studies have investigated the implications of gender diversity on learning experience, for instance, in terms of outcome and satisfaction (Al-Azawei & Lundqvist, 2014; Hong, 2002; Lau & Yuen, 2009). However, the results were inconsistent suggesting further research (Shore et al., 2009). Gefen & Straub (1997) stated that women’s responses to certain situations tend to be different than men’s. This suggests that IT theories and technology acceptance research should attempt to consider gender differences. Cagiltay, Yildirim, & Aksu (2006) demonstrated that males and females are inclined to adopt different learning methods; women preferred a linear approach, whereas men tend to adopt a non-linear one. Gefen & Straub (1997) extended TAM by adding gender as one of the fundamental cultural differences. The inspection of the incorporated sample did not show that gender affected e-mail adoption. However, men and women differed in their perceptions. Moreover, Ong & Lai (2006) recommended that researchers should consider gender diversity during the investigations of e-learning theories. Significant dissimilarities were found between men and women with regard to PU, PEOU, computer self-efficacy, and behavioural intention to adopt e-learning (Ong & Lai, 2006). Based on such literature, gender diversity was included to examine the causal relationship among these factors.

**H2a**: Learners’ gender diversity positively affects perceived usefulness (PU) in online learning.

**H2b**: Learners’ gender diversity positively affects perceived satisfaction (PS) in online learning.

**H2c**: Learners’ gender diversity positively affects perceived ease of use (PEOU) in online learning.

### 3.3 Cognitive factor (online self-efficacy OSE)

Self-efficacy was defined as a learner’s cognitive beliefs affecting their behaviour when using a technology (Wu, Tennyson, & Hsia, 2010). In this context, the technology refers to online learning. Some studies identified anxiety and computer skills as parameters influencing the online learning experience (Hong, 2002; Sun et al., 2008). However, we excluded them from our study, as all subjects, except for two, belonged to the computer science field. In addition to perceived usefulness and ease of use as two identified cognitive factors in the TAM, we included online self-efficacy (OSE) as another cognitive construct because e-learning had recently been used in Iraq.

As literature indicates, the effect of OSE on learning experience has been empirically investigated (Johnson et al. 2008; Liaw 2008; Ong & Lai, 2006; Sun et al. 2008). Based on the concept of OSE as a reflection of learners’ expectations, it was anticipated to be a significant factor which might influence PU (Ong & Lai, 2006). Investigating the causal link between self-efficacy (SE) and PEOU showed the importance of this factor to predict the latter (Ong & Lai, 2006; Weiyin, James, Wai-Man, & Kar-Yan, 2001) . Additionally, Sun et al. (2008) found that SE was a predictor of PS. Accordingly, we suggest that OSE is an influential factor in online learning.

**H3a**: Online self-efficacy (OSE) positively affects perceived usefulness (PU) in online learning.
H3b: Online self-efficacy (OSE) positively affects perceived ease of use (PEOU) in online learning.
H3c: Online self-efficacy (OSE) positively affects perceived satisfaction (PS) in online learning.

3.4 Perceived usefulness (PU)

Perceived usefulness was defined as “the degree to which an individual believes that using a particular system would enhance his or her performance” (Davis, 1986, p26). It was suggested that perceived usefulness (PU) has a significant impact on accepting a technology, and that it can explain a user’s attitude (Davis, 1986). As shown in literature, PU was a substantial predictor of perceived satisfaction weather in blended or online learning (Liaw, 2008; Sun et al., 2008). The criteria of Learners when rating the usefulness of a technology rely on their expectation that a technology will aid towards outcome amelioration and goal achievement. Online learning represents a new trend in the developing countries, and more specifically Iraq. Thus, we hoped to investigate learner satisfaction of online learning in accordance with this factor.

H4: Perceived usefulness (PU) positively affects perceived satisfaction (PS) in online learning.

3.5 Perceived ease of use (PEOU)

Perceived ease of use was defined as “the degree to which an individual believes that using a particular system would be free of physical and mental effort” (Davis, 1986, p26). Hence, TAM and the Technology Acceptance Model 2 (TAM2) illustrated PEOU significance in determining PU and users’ attitudes towards a technology (Davis, 1986; Venkatesh & Davis, 2000). It directly associates with PS because learners, more specifically in non-mandatory courses, are reluctant to continue using an online system if they face difficulties in employing it and may be prone to dropping a course or to searching for an alternative learning environment. Therefore, literature has linked PEOU with PS (Liaw, 2008; Sun et al., 2008). Grounded on such findings, PEOU was regarded as an influential factor on PU and PS.

H5a: Perceived ease of use (PEOU) positively affects perceived usefulness (PU) in online learning.
H5b: Perceived ease of use (PEOU) positively affects perceived satisfaction (PS) in online learning.

3.6 Perceived satisfaction (PS)

Investigating factors that influence learner satisfaction can play a vital role in understanding the path to success in an e-learning situation and it is hoped that consideration of such variables will contribute to an enhancement of learning experience. Learner satisfaction means easily reflects outcomes of reciprocity that occur between students and an instructor instructor...keeps an instructor on his or her toes as a double-check to make sure that material is relevant and current or that students see themselves learning.... (Guolla, 1999 as cited in Thurmond, Wambach, Connors, & Frey, 2002, p176).

Furthermore, Wu, Tennyson, & Hsia (2010) define learner satisfaction as the acquisition of all the advantages a learner aims to receive from learning, as per his behavioural beliefs and attitudes. Based on these definitions, PS is a key factor stemming from the completion of a learning task, where the aimed outcomes derive enjoyably. Bolliger & Wasilk (2009) accounted perceived satisfaction as a vital aspect to continue learning.

Educational institutions should give special consideration to meet learner satisfaction. From a commercial perspective, students are similar to customers. Thus, their learning needs should be met. From a learning point of view, students cannot learn properly if they feel that there are environmental or personal barriers preventing them to achieve their objectives. As a result, Donohue & Wong (1997) indicated that learners level of motivation is affected by their satisfaction.

Many variables can influence perceived satisfaction. Bolliger & Martindale (2004) discussed three factors that represent a central key of learner satisfaction in online learning: instructors, technology, and interactivity. The learner factor, however, is not of less importance than these factors. Table 1 chronologically summarises some studies that examined the impacts of several variables on learner satisfaction.
Table 1: Literature review

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>sample</th>
<th>Examined variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong (2002)</td>
<td>26</td>
<td>Computer experience, gender, age, scholastic aptitude, learning styles, student–instructor and student–student interactions, perception of the course activities, asynchronous, and time spent on the course.</td>
</tr>
<tr>
<td>Johnson, Hornik, &amp; Salas (2008)</td>
<td>345</td>
<td>Application-specific computer self-efficacy (AS-CSE), technology usefulness, interaction and social presence.</td>
</tr>
<tr>
<td>Sun et al. (2008)</td>
<td>295</td>
<td>Learner dimension (Learner attitude towards computers, Learner computer anxiety and Learner Internet self-efficacy), Instructor dimension (Instructor response timeliness and Instructor attitude towards e-Learning), Course dimension (E-Learning course flexibility and E-Learning course quality), Technology dimension (Technology quality and Internet quality), Design dimension (Perceived usefulness and Perceived ease of use) and Environmental dimension (Diversity in assessment and Learner perceived interaction with others).</td>
</tr>
<tr>
<td>Wu, Tennyson, &amp; Hsia (2010)</td>
<td>212</td>
<td>Cognitive variables (self-efficacy and performance expectations), Technological environment (system functionality, content feature) and Social environment (interaction).</td>
</tr>
<tr>
<td>Cole, Shelley, &amp; Swartz (2014)</td>
<td>553</td>
<td>Interaction (including communication), convenience, structure (including clarity and instructor’s facility with online instruction), learning style, platform, gender, age and the level of study.</td>
</tr>
</tbody>
</table>

4 Research Methodology

4.1 Context

Moodle was installed on the University of Reading server under the name of Arabic Programming. It is available on http://arabic-programming.reading.ac.uk/ and offers different courses for Arabic learners who are interested in computer science and programming languages. Anyone can register with the system and have access to all provided courses.

Learners who registered in a web design course in the online learning system were requested to participate in the study. The course was delivered in seven weeks from the middle of October to December 2014 to teach web design using Hypertext Markup Language (HTML) and Cascading Style Sheet (CSS). Every lecture included videos, written text as a pdf file, figures, and examples. The video lectures were divided into small parts because of the low internet bandwidth in Iraq. Each lecture comprised at least two to five videos and lasted between 10 to 15 minutes. Furthermore, four lectures included self-assessment tests. Forums and wiki were activated to discuss course content, and questions were posted that had to be answered by participants. Although the written lectures were in English, the course was taught and explained in the Arabic language.

The course was intentionally designed to serve one pole in each dimension of FSLSM (Felder & Silverman, 1988), more specifically, it considered the characteristics of active, sensing, visual, and sequential learners.

- Processing (active/reflective): An active learner prefers to do something, self-assessment and group work. These preferences were served by adopting learning-by-doing approach, adding self-assessments to four lectures, and activating interaction tools in the system to allow learners to work with their peers.
- Perception (sensing/intuitive): A sensing learner tends to prefer facts and no complex concepts. This course was delivered for novice learners who do not have previous knowledge of web design. Therefore, it only entailed general information about web design without any complex concepts and without high level programming that required more thinking. Furthermore, several examples were provided with each lecture to meet the preferences of this style.
- Input (visual/verbal): A visual learner tends to use pictorial materials rather than written text. Although written lectures were provided, they included only the head points. Therefore, the course relied on video lectures and figures to explain the content, and thus served the preferences of a visual learner rather than a verbal one. Overall, the course consisted of 27 short video lectures.
Understanding (sequential/global): A sequential learner prefers a step-by-step learning approach and focuses on surface details before getting the whole picture. The course was sequentially presented by providing all details regarding the principles of web design in HTML and CSS, starting from scratch to cover all relevant details, and then to develop learners’ knowledge step by step. In the last lecture, all delivered materials were connected by designing a whole website which used all explained content. As such, sequential learners who are patient with details may find the course more suitable for their needs.

The purpose of this design was to quantitatively compare user satisfaction in accordance with their styles and preferences. Furthermore, in order to avoid any bias in the responses to the distributed questionnaires, learners were not informed that the course design served particular preferences. Figures 2 and 3 illustrate the main page of the course and the use of multimedia instructions in teaching and learning.

Figure 2: The course’s main page.


4.2 Participants

A short video was posted on Facebook to introduce the course and show users how to self-enrol. In addition, many lecturers in different computer science colleges in Iraq were contacted to encourage their students to participate. A total of 144 learners registered on the course. In total, 88 (61.11%) learners filled in the distributed questionnaires. However, 18 users who filled out either the learning styles questionnaire or the standard survey were excluded from this investigation. As such, 70 (48.61) learners represented the total subjects of this study. The demographic features of participants are presented in Table 2. The area of study of all participants was IT or computer science, except for two. However, these two cases were not excluded from the analysis because the overall findings would not be affected by such small rate (2.8%).

Table 2: Demographic features (N=70)

<table>
<thead>
<tr>
<th>Item</th>
<th>N (%)</th>
<th>Item</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender:</td>
<td></td>
<td>Area of Study:</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>27 (38.6)</td>
<td>Computer Science or Information Technology</td>
<td>68 (97.1)</td>
</tr>
<tr>
<td>Female</td>
<td>43 (61.4)</td>
<td>To some Extent Relate to Computer Science</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Level of Study:</td>
<td></td>
<td>Age Group:</td>
<td></td>
</tr>
<tr>
<td>Undergraduate</td>
<td>59 (84.3)</td>
<td>18-21</td>
<td>57 (81.4)</td>
</tr>
<tr>
<td>BSc</td>
<td>7 (10)</td>
<td>22-25</td>
<td>7 (10)</td>
</tr>
<tr>
<td>MSc</td>
<td>1 (1.4)</td>
<td>26-29</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>3 (4.3)</td>
<td>30-33</td>
<td>2 (2.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>34-37</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>38-41</td>
<td>2 (2.9)</td>
</tr>
</tbody>
</table>

4.3 Data collection

In order to gather data, online-based surveys were used. This comprised two questionnaires to identify the demographic features of participants, learning styles, and the identified factors. The questionnaires included a brief explanation about the objective of carrying out this research, also guaranteeing confidential manipulation of all data.

During week six, subjects were requested to participate in the video lectures, using the announcement page of the Moodle system and sending an email to all learners. After ten days, the URLs of both instruments were
announced again on the Moodle and a reminder email was sent to all participants. The questionnaires were administered in December 2014 and for approximately a month. All questions in both instruments were translated into the Arabic language. Two PhD students at two different universities in the UK who speak Arabic as a mother language checked the translation in order to verify it. According to their feedback, some questions were modified.

4.3.1 The Index of Learning Styles (ILS)

This psychometric instrument was proposed in order to infer learning styles in accordance with FSLSM (Felder & Silverman, 1988). The questionnaire comprised 44 forced-choice questions. Eleven questions were asked to identify each of the four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of FSLSM (Felder & Soloman, n.d.). For each question users could choose either ‘a’ or ‘b’. The two options corresponded to one or the other pole in each dimension for instance, ‘a’ for active style and ‘b’ for reflective one. This design allowed for the identification of mild, moderate, and strong preferences in each dimension. In order to carry out the statistical analysis with regard to learning style dimensions, the following procedure was followed. Initially, 1 was assigned to all ‘a’ options and 0 to all ‘b’ options. This produced integer values ranging from 0 to 11. Then, Felder & Spurlin (2005) suggested defining, for example, for the processing (active/reflective) dimension, a score of 0-1 as a ‘strong-reflective’, 2-3 as a ‘moderate-reflective’, 4-5 as a ‘mild-reflective’, 6-7 as a ‘mild-active’, 8-9 as a ‘moderate-active’, and 10-11 as a ‘strong-active’. Figure 4 illustrates the scores distribution of learning styles. The main tendencies of students were towards active (68.5%), sensing (72.8%), visual (75.7%), and sequential (65.7%) styles (including those with mild preferences).

Figure 4: Distribution of learning style scores

4.3.2 A standard questionnaire

To begin with, three e-learning experts examined the questionnaire in order to improve its face-structure. As a result, some questions were excluded, while others were modified. The questionnaire included the following parts:

- Demographic data: gender, age group, level of study, area of study, internet, and e-learning experience. The last two features were identified by using a 7-point Likert scale ranging from 1 for ‘strongly disagree’ to 7 for ‘strongly agree’.
The closed-ended questions: sixteen questions were used to identify the four factors: OSE (5 indicators), PU (3 indicators), PEOU (3 indicators), and PS (5 indicators). A 7-point Likert scale ranging from 1 for ‘strongly disagree’ to 7 for ‘strongly agree’ was used. This scale was adopted in order to give learners more flexibility to express their preferences. The questions were self-developed and adapted from literature (Johnson et al., 2008; Liaw, 2008; Sun et al., 2008; Piccoli et al., 2001; Wu et al., 2010). Appendix A presents the items of each construct in the proposed model.

An open-ended question: this was an optional question that learners can answer or ignore. It aimed to qualitatively identify learners’ perspectives with regard to the advantages and disadvantages of online learning and attending this course via internet. Although all comments of the nine participants who answered this question were positive, the qualitative analysis was excluded due to the small number of responses.

4.4 Analysis techniques

In order to investigate the proposed hypotheses, the software SPSS (Statistical Package for the Social Sciences) version 22 and SmartPLS version 3.0 for Windows 7 were used. Different descriptive and inferential statistics were conducted. This included the computing of mean (M), frequency, standard deviation (SD), Cronbach’s α, Pearson’s correlation, factor analysis, and PLS method. The p value at 0.05 was adopted to investigate the significant correlation between variables.

5 Results and discussion

The participants demonstrated good knowledge of the internet, and familiarisation with online learning. This was unsurprising because, except for two, all were studying or have graduated from computer science or information technology schools. However, they were not very experienced at using the internet (M=4.90, SD=1.571) and e-learning (M=4.70, SD=1.662). This result was compatible to our initial expectations because the use of such technologies, particularly online learning is still in its infancy in Iraq. Pearson’s coefficient showed a mild, but significant correlation among internet, e-learning experience, and PS (r=0.28, P=0.018 and r=0.24, P=0.041) for both variables respectively.

5.1 Differences between groups

Pearson correlation coefficient of gender diversity among PU, PEOU, and PS was also computed before conducting the PLS model. This was essential prerequisite to understand the level of correlation between independent and dependent factors. The results did not demonstrate any significant correlation (r=0.098, P=0.41), (r=0.076, P=0.53), and (r=0.074, P=0.54), for the three factors respectively. In order to reveal any significant differences among learning styles, PU, and PS, one-way ANOVA was conducted. The results are reported in Table 3. It is clear that there are no significant differences between learning style groups and the dependent factors (PU and PS).

<table>
<thead>
<tr>
<th>Learning style</th>
<th>Perceived Satisfaction (PS)</th>
<th>Perceived Usefulness (PU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>F</td>
</tr>
<tr>
<td>Active</td>
<td>5.75</td>
<td>0.99</td>
</tr>
<tr>
<td>Reflective</td>
<td>6.03</td>
<td>0.58</td>
</tr>
<tr>
<td>Sensing</td>
<td>5.91</td>
<td>0.83</td>
</tr>
<tr>
<td>Intuitive</td>
<td>5.64</td>
<td>1.03</td>
</tr>
<tr>
<td>Visual</td>
<td>5.84</td>
<td>0.82</td>
</tr>
<tr>
<td>Verbal</td>
<td>5.83</td>
<td>1.10</td>
</tr>
<tr>
<td>Sequential</td>
<td>5.79</td>
<td>0.99</td>
</tr>
<tr>
<td>Global</td>
<td>5.93</td>
<td>0.66</td>
</tr>
</tbody>
</table>

5.2 Instrument properties

Pallant (2013) indicated that Cronbach’s coefficient alpha is a widely used indicator to measure the construct-internal consistency of a measurement. The overall result indicated high-consistency reliability (α=0.90). The αs, as presented in Table 6, showed that all factors were at a good level of reliability. For further investigation, Pearson coefficient correlation was used to conduct the inter-scale and total items correlation. There is a significant correlation between all scales and most items as presented in Tables 4 and 5. However, the highest
correlation among scales is 0.585 between perceived usefulness and perceived satisfaction. The multicollinearity assumption was not violated as the results of tolerance and VIF (Variance Inflation Factor) revealed (Table 4).

Table 4: Pearson correlation coefficient (Inter-scales correlation)

<table>
<thead>
<tr>
<th></th>
<th>PU</th>
<th>PEOU</th>
<th>PS</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSE</td>
<td>0.488**</td>
<td>0.558**</td>
<td>0.410**</td>
<td>0.634</td>
<td>1.578</td>
</tr>
<tr>
<td>PU</td>
<td>0.515**</td>
<td>0.585**</td>
<td>0.677</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEOU</td>
<td>0.418**</td>
<td></td>
<td>0.612</td>
<td></td>
<td>1.635</td>
</tr>
</tbody>
</table>

* *Correlation is significant at the 0.01 level (2-tailed).

According to Pallant (2013), in order to carry out the factor analysis test, the correlation matrix should reveal a correlation of at least 0.3 among some items. Furthermore, the Bartlett’s test of sphericity and the Kaiser-Meyer-Olkin (KMO) as commonly used measures to check whether the factorability of data achieves less or equal to 0.05 and 0.6 as a minimum value for both tests respectively. These criteria were matched in this analysis. The KMO was 0.815 and the Bartlett’s test of sphericity was significant at \( p \) less than 0.001. As such, the results support the factorability of the correlation matrix.

The Principle Components Analysis (PCA) extracted the presence of 4 factors to explain 69.5% of variance. Factors 1, 2, 3, and 4 loaded all items of the four scales as illustrated in Appendix B. The “scree plot” of eigenvalues (Figure 5) also showed a smooth decrease in eigenvalues after factor 4. The four-factor model perfectly identified the four constructs and strongly loaded all items. For further analysis, Wixom & Todd (2005) stated that the convergent and discriminant validity can be proven if the items’ load on their associated constructs is above 0.5 and higher than their loaded across factors (Appendix B). Hair, Black, Babin, Anderson, & Tatham (2006) stated that the convergent validity can be established when the values of average variance extracted (AVE) and composite reliability (CR) are higher than the acceptable level of 0.5 and 0.7. Furthermore, if the variance shared between any variable and other factors in the tested model is less than the variance that a variable shares with its own factors, discriminant validity can be supported (Fornell & Larcker, 1981). Table 6 illustrates that AVE and CR exceeded the thresholds to support the convergent validity and the discriminant validity was advocated as well.

Table 5: Pearson correlation coefficient (Inter-items correlation)

<table>
<thead>
<tr>
<th></th>
<th>OSE</th>
<th>PU</th>
<th>PEOU</th>
<th>PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSE2</td>
<td>.612**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSE3</td>
<td>.269</td>
<td>.362**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>OSE4</td>
<td>.478**</td>
<td>.619**</td>
<td>.513**</td>
<td>1</td>
</tr>
<tr>
<td>OSE5</td>
<td>.521**</td>
<td>.517**</td>
<td>.526**</td>
<td>.530**</td>
</tr>
<tr>
<td>PEOU1</td>
<td>.301</td>
<td>.402**</td>
<td>.316**</td>
<td>.525**</td>
</tr>
<tr>
<td>PEOU2</td>
<td>.357**</td>
<td>.359**</td>
<td>.268*</td>
<td>.418**</td>
</tr>
<tr>
<td>PEOU3</td>
<td>.397**</td>
<td>.333**</td>
<td>.390**</td>
<td>.440**</td>
</tr>
<tr>
<td>PU1</td>
<td>.440**</td>
<td>.355**</td>
<td>.268*</td>
<td>.318**</td>
</tr>
<tr>
<td>PU2</td>
<td>.262</td>
<td>.341**</td>
<td>.201</td>
<td>.320**</td>
</tr>
<tr>
<td>PU3</td>
<td>.318**</td>
<td>.374**</td>
<td>.281*</td>
<td>.409**</td>
</tr>
<tr>
<td>PS1</td>
<td>.175</td>
<td>.310**</td>
<td>.298*</td>
<td>.337**</td>
</tr>
<tr>
<td>PS2</td>
<td>.246</td>
<td>.283*</td>
<td>.251*</td>
<td>.374**</td>
</tr>
<tr>
<td>PS3</td>
<td>.232</td>
<td>.226</td>
<td>.184</td>
<td>.468**</td>
</tr>
<tr>
<td>PS4</td>
<td>.029</td>
<td>.199</td>
<td>.115</td>
<td>.177</td>
</tr>
<tr>
<td>PS5</td>
<td>.116</td>
<td>.365**</td>
<td>.220</td>
<td>.451**</td>
</tr>
</tbody>
</table>

* *Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).
Figure 5: Scree plot for factor analysis of the questionnaire (n=70)

Table 6: Findings of the measurement model

<table>
<thead>
<tr>
<th>Latent factor</th>
<th>AVE (&gt;0.5)</th>
<th>CR (&gt;0.7)</th>
<th>Cronbach’s α</th>
<th>Discriminant validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSE</td>
<td>0.598</td>
<td>0.881</td>
<td>0.830</td>
<td>OSE 0.773</td>
</tr>
<tr>
<td>PEOU</td>
<td>0.661</td>
<td>0.854</td>
<td>0.745</td>
<td>OPEOU 0.575</td>
</tr>
<tr>
<td>PS</td>
<td>0.696</td>
<td>0.920</td>
<td>0.891</td>
<td>PS 0.433</td>
</tr>
<tr>
<td>PU</td>
<td>0.748</td>
<td>0.899</td>
<td>0.832</td>
<td>PU 0.496</td>
</tr>
</tbody>
</table>

5.3 Hypotheses investigation

PLS-SEM was used to test the path associated in the proposed model. This is due to many reasons: it is applied to reveal the relationship between independent and dependent variables, specifically, when a dependent factor is used as an independent one in a model (PEOU and PU in this study) (Tarhini et al., 2015), it is adequate for small sample size (Barrio-garcía, Arquero, & Romero-frias, 2015; Chin, 1998; Yi & Hwang, 2003), and it was predominant in prior TAM related work (Barrio-García et al., 2015; Yi & Hwang, 2003).

The study aimed to modify the TAM by integrating several learner factors to evaluate learner satisfaction in online learning instead of attitude to use a technology. Generally, four hypotheses were retained and seven were rejected. Table 7 depicts that neither learning styles nor gender diversity showed any direct significant effect on PU, PEOU, and PS, OSE had direct significant influences on PU and PEOU, PEOU had direct significant effect on PU, and PU was the best predictor of PS. In Figure 6, the path associated between variables after carrying out the PLS modelling is presented. The four dimensions of learning styles were abbreviated to $\beta_{\text{Proc}}$, $\beta_{\text{Per}}$, $\beta_{\text{Inp}}$, and $\beta_{\text{Und}}$ for Processing, Perception, Input, and Understanding respectively. The independent factors explained 44.8% of variance where PU was the strongest predictor.
### Table 7: Hypotheses analysis

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>$R^2$</th>
<th>Direct effect</th>
<th>Standardised estimate</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent PU</strong></td>
<td>0.340</td>
<td>0.366</td>
<td>2.277</td>
<td>0.019</td>
</tr>
<tr>
<td>H5a: PEOU $\rightarrow$ PU</td>
<td></td>
<td></td>
<td></td>
<td>0.366 Supported</td>
</tr>
<tr>
<td>H3a: OSE $\rightarrow$ PU</td>
<td></td>
<td>0.268</td>
<td>2.010</td>
<td>0.037</td>
</tr>
<tr>
<td>H2a: Gender $\rightarrow$ PU</td>
<td></td>
<td>0.001</td>
<td>0.008</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.213</td>
<td>0.111</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.016</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.481</td>
<td>0.0122</td>
</tr>
<tr>
<td>H1a: LS $\rightarrow$ PU</td>
<td>0.331</td>
<td>-0.069</td>
<td>0.596</td>
<td>0.53</td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td>-0.079</td>
<td>0.568</td>
<td>0.58</td>
</tr>
<tr>
<td>Input</td>
<td></td>
<td>0.069</td>
<td>0.673</td>
<td>0.51</td>
</tr>
<tr>
<td>Understanding</td>
<td></td>
<td>-0.009</td>
<td>0.067</td>
<td>0.95</td>
</tr>
<tr>
<td>H5b: PEOU $\rightarrow$ PEOU</td>
<td></td>
<td>0.581</td>
<td>4.185</td>
<td>&lt;0.001</td>
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<tr>
<td>H3b: OSE $\rightarrow$ PEOU</td>
<td></td>
<td>0.030</td>
<td>0.313</td>
<td>0.74</td>
</tr>
<tr>
<td>H2c: Gender $\rightarrow$ PEOU</td>
<td></td>
<td></td>
<td></td>
<td>0.030 Rejected</td>
</tr>
<tr>
<td><strong>Dependent PS</strong></td>
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<td>0.069</td>
<td>0.435</td>
<td>0.65</td>
</tr>
<tr>
<td>H5b: PEOU $\rightarrow$ PS</td>
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<td>0.467</td>
<td>3.210</td>
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</tr>
<tr>
<td>H4: PU $\rightarrow$ PS</td>
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<td>0.245</td>
<td>1.214</td>
<td>0.22</td>
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<tr>
<td>H3c: OSE $\rightarrow$ PS</td>
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<td>-0.076</td>
<td>0.637</td>
<td>0.48</td>
</tr>
<tr>
<td>H1b: LS $\rightarrow$ PS</td>
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<td>0.259</td>
<td>1.759</td>
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</tr>
<tr>
<td>Processing</td>
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<td>Input</td>
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<td>0.76</td>
</tr>
<tr>
<td>Understanding</td>
<td></td>
<td>0.032</td>
<td>0.028</td>
<td>0.155</td>
</tr>
<tr>
<td>H2b: Gender $\rightarrow$ PS</td>
<td></td>
<td>-0.076</td>
<td>0.259</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.033</td>
<td>0.288</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.007</td>
<td>0.155</td>
<td>-0.025</td>
</tr>
</tbody>
</table>

**Figure 6: The results of the proposed hypotheses**

As presented in this analysis, learning styles did not seem to predict PU (H1a) and PS (H1b). Although literature did not investigate the effects of learning styles on PU in an adaptable learning setting, we suggested such influence based on learning styles hypothesis. Contrary to our assumption, H1a was rejected because learning style dimensions were not predictors of PU as shown in Table 7. With regard to H1b, our result is in agreement with the findings of Hong (2002) that learning styles did not significantly influence PS. Cheng & Chau (2014) argued that learning styles are significantly associated with online participation and the latter, in turn, is associated with learner satisfaction. This result indirectly relates learning styles with PS. However, we deliberately designed the online learning environment to match the preferences of particular poles in the FSLSM. This adaptation presented an insignificant effect among the four dimensions and PS (Table 7), whereas Cheng & Chau (2014) did not explore this point. Accordingly, this research indicates that other factors are more likely to affect learner satisfaction than learning styles. It could be argued that the online environment matched the preferences of the majority of participants because most of them were tend to active, sensing, visual, and
sequential. Nevertheless, the mean differences of PS for the dichotomies were not substantial enough to confirm our conclusion. This discussion was also supported by the findings of ANOVA test (Table 4). This means that regardless of matching or mismatching groups, learning styles as a factor cannot predict PU and PS. In addition to the theoretical critique regarding learning styles (Mayer, 2011; Pashler et al., 2008), this analysis adds more empirical debate with aspect to the implications of this trait.

Pertaining to gender diversity hypotheses, Ong & Lai (2006) integrated gender diversity in TAM to investigate e-learning acceptance. The study indicated the significance of gender differences. Male perceptions of computer self-efficacy, PU, and PEOU were significantly higher than female ones, and then the intention to use e-learning was different. In contrast, Gefen & Straub (1997) indicated that PU and PEOU for women was significantly higher than men. Such results were inconsistent with our findings, as gender was neither a predictive of PU (βGender→PU = -0.001, P=0.994) nor PEOU (βGender→PEOU = -0.030, P=0.754). Based on this analysis, H2a and H2c were rejected. Furthermore, H2b suggested that PS was significantly affected by gender diversity. Contrary, PLS did not show such significant relationship (βGender→PS =-0.033, P=0.774). This result is in accordance with studies that pointed out gender was not an affective factor to predict learner satisfaction (Hong, 2002; Vanderheyden & De Baets, 2015). To conclude, literature has produced inconsistent results concerning the value of gender diversity. This might be explained by cultural differences because gender was accounted as one of the aspects of cross-cultural differences (Gefen & Straub, 1997).

Following online self-efficacy (OSE) hypotheses, this factor was a predictive of PU (H3a) and it was a strong predictor of PEOU (H3b) where the results were (βOSE→PU = 0.268, P=0.045) and (βOSE→PEOU = 0.581, P<0.001) for both hypotheses respectively. These results are consistent with other studies, for instance, Ong & Lai (2006). We also assumed a causal link between OSE and PS, as learners may be unsatisfied if they were not confident enough to use this technology and it represented new experience for them (H3c). However, this hypothesis was not confirmed (βOSE→PS = 0.245, P=0.225) to support the finding of Liaw (2008), whereas Sun et al. (2008) found that it was a predictor of PS. However, as mentioned previously, the sample included current students or graduates of computer science. Therefore, to some extent their OSE was over the expected level, as such other factors were more likely to predict learner satisfaction.

With regard to PU hypothesis (H4), this research supported the findings of Barrio-garcia, Arquero, & Romero-frias (2015), Davis (1986), Drennan et al. (2005), Venkatesh & Davis (2000), and Sun et al. (2008) to indicate that PU was the strongest predictor of technology acceptance or learner satisfaction (βPU→PS = 0.467, P<0.001). This means that participants found online learning to be a useful technology to achieve their goals and improve learning outcomes and this, in turn, undoubtedly affects their satisfaction. Specifically, it represents new experience for Iraqi students. Thus, in order to ensure continuous use of a learning technology, useful and interactive teaching methods that can promote academic achievement should be used.

Following PEOU hypotheses, as assumed in the TAM and TAM2, PEOU was a direct determinant of PU (Davis, 1986; Venkatesh & Davis, 2000). Our analysis of H5a verified this assumption (βPEOU→PU = 0.366, P=0.023). Such result supported the previous literature (Davis, 1986; Ong & Lai, 2006; Venkatesh & Davis, 2000). Tarhini et al. (2015), on the other hand, found that these factors are uncorrelated. Furthermore, contrary to our assumption that PEOU will significantly affect PS (H5b), the analysis rejected this hypothesis (βPEOU→PS = 0.069, P=0.664). Similarly, Drennan et al. (2005) and Tarhini et al. (2015) revealed that PU was a determinant of PS or attitude to use a technology, whereas PEOU was not. On the other hand, Sun et al. (2008) pointed out the significance of PEOU to determine learner satisfaction. Our finding can be interpreted according to the experience level of participants in online learning because all, but two, came from Information Technology and Computer Science majors. Therefore, they did not face any difficulty to work in that environment due to their individual skills. This justification can also be advocated by the interpretation of Tarhini et al. (2015) that PEOU is a critical factor in the early stage of adoption. Additionally, the significance of PEOU on e-learning or e-mail technologies was shown in the prematurity era of such technologies (Gefen & Straub, 1997; Ong & Lai, 2006; Venkatesh & Davis, 2000). Therefore, the maturity of current e-learning technologies may help learners to use them even if they are less experienced. In other words, this does not mean that PEOU is not a significant factor, however, it may mean that the use of superior and usable learning technologies supports delivering e-learning more easily.

In summary, the modified model explained 44.8% of variance. PU was the best predictor, whereas all other integrated factors did not show a direct significant contribution. In general terms, the overall results slightly enhanced the findings of the original TAM where the model typically explained 40% of variance (Venkatesh & Davis, 2000).
6 Implications and limitations

The overall results are promising because they are indicative of the high degree of satisfaction and perceived usefulness of Iraqi learners with regard to online learning. This should encourage the MHESR-I to establish an integrated infrastructure to extend the use of online learning or blended learning in public universities in order to improve learning quality and motivate students towards new learning technologies. Specifically, the contributions of the research are fourfold. To begin with, although it modified TAM to predict satisfaction instead of technology adoption, it moderately supported the original factors of the TAM in an Arabic population sample. On the other hand, all extended factors were not direct predictors of learner satisfaction. Moreover, the study contributed to the existing debate by pointing out the modest effect of learning styles on educational practice as indicated in other works (Mayer, 2011; Pashler et al., 2008). Some reported studies such as Brown (2007) qualitatively analysed the implications of learning styles on perceived satisfaction in an adaptive learning environment to indicate that this adaptation improved learner satisfaction albeit this trait did not influence academic performance. However, in order to investigate the effectiveness of learning styles on such factors, it is essential that learners are unaware that an online course is designed according to their individual preferences so that a placebo effect scenario is prevented. Our result may suggest that there is no need to personalise educational hypermedia systems (EHSs) according to this trait because students can easily adapt to different learning circumstances even if such environments do not address their individual preferences. Furthermore, the surface level factor (gender) is influenced by several cultural and environmental variables (Gefen & Straub, 1997). Therefore, we recommend further investigation to reveal the effectiveness of gender diversity in developing countries not least in regions where cultural customs impose restrictions on female education. Mixing quantitative and qualitative analysis can provide more in-depth understanding about the role of gender in such cultures. Finally, the cognitive factor (OSE) is directly linked with PU and PEOU, but its effect on PU and PS may also depend on other variables such as individual skills, user experience, and the maturity of a particular technology.

It is worth mentioning that this study is subject to many limitations. First, the sample size is quite small and homogeneous. Investigating larger and heterogeneous population can provide more reliable results. Thus, the findings of the study should be interpreted cautiously. Second, the data were collected from subjects who attended one online course. Hence, this may represent their subjective opinion regarding that individual course. Collecting data from different courses could allow for more encompassing interpretations.

7 Conclusion

Meeting user satisfaction represents a key factor for success in online learning. This study modified TAM to achieve this goal. The results showed that not all identified factors can predict perceived satisfaction. However, the perceived usefulness as an original factor in TAM represents the best predictor. Although online self-efficacy and perceived ease of use did not directly affect perceived satisfaction, this was explained according to the individual experience of learners and the maturity of a particular technology.

The study focused on the role of learning styles to determine learner satisfaction. Some of the learning tendencies were intentionally mismatched to serve only other styles. However, the results did not show any statistical significance among perceived satisfaction and the matched or mismatched groups. This means that variables other than learning styles may significantly affect learner satisfaction. Based on this result, it should be recommended that when researchers aim to investigate the pedagogical implications of learning styles, students should not be aware that an online course is designed in accordance with their styles, so that the placebo effect is prevented. In other words, if learners are informed that the course is adapted as per their individual preferences and styles, this might psychologically predispose them to positively respond to qualitative or quantitative questions. This may explain the contradictory findings regarding the implications of learning styles on learner satisfaction. In future work, a larger sample will be used to substantiate the findings. Additionally, it would be more feasible to collect data from a heterogeneous sample in order to avoid any bias that could be emerged in a homogeneous one. Other independent factors can be incorporated in order to enhance the model.

Acknowledgment

The authors would like to thank the Iraqi Ministry of Higher Education and Scientific Research for sponsoring this study. They are also grateful to Dr Lina P Varotsi for her constructive feedback that helped to improve this paper.
References


www.ejel.org


### Appendix A: The questionnaire items, mean, and standard deviation

<table>
<thead>
<tr>
<th>Factors</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
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<tr>
<td><strong>Online Self-efficacy (OSE):</strong></td>
<td>5.08</td>
<td>1.12</td>
</tr>
<tr>
<td>1) I believe that I have the ability to post comments and respond to comments posted in the course discussion forum.</td>
<td>5.06</td>
<td>1.30</td>
</tr>
<tr>
<td>2) I believe that I have the ability to locate information on the course website.</td>
<td>5.43</td>
<td>1.29</td>
</tr>
<tr>
<td>3) I believe that I have the ability to use all Moodle features.</td>
<td>4.69</td>
<td>1.78</td>
</tr>
<tr>
<td>4) I feel confident using online learning systems after participating in this course.</td>
<td>5.44</td>
<td>1.28</td>
</tr>
<tr>
<td>5) I feel confident using online learning systems before participating in this course.</td>
<td>4.79</td>
<td>1.65</td>
</tr>
<tr>
<td><strong>Perceived Ease of Use (PEOU):</strong></td>
<td>5.44</td>
<td>1.00</td>
</tr>
<tr>
<td>6) I found that all functions can be used easily even with less experience in online learning.</td>
<td>5.53</td>
<td>1.17</td>
</tr>
<tr>
<td>7) I found that the online learning system can be used easily.</td>
<td>5.43</td>
<td>1.34</td>
</tr>
<tr>
<td>8) I found it is easy to do what I want in the online learning system.</td>
<td>5.39</td>
<td>1.15</td>
</tr>
<tr>
<td><strong>Perceived Usefulness (PU):</strong></td>
<td>6.09</td>
<td>0.92</td>
</tr>
<tr>
<td>9) I believe online learning is a useful learning tool.</td>
<td>6.09</td>
<td>1.15</td>
</tr>
<tr>
<td>10) I believe online learning is useful.</td>
<td>6.16</td>
<td>1.03</td>
</tr>
<tr>
<td>11) I believe online learning improves learning outcomes.</td>
<td>6.04</td>
<td>1.04</td>
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<tr>
<td><strong>Perceived Satisfaction (PS):</strong></td>
<td>5.84</td>
<td>0.89</td>
</tr>
<tr>
<td>12) I am satisfied with using online learning as a learning assisted tool.</td>
<td>5.77</td>
<td>1.01</td>
</tr>
<tr>
<td>13) I am satisfied with using online learning functions.</td>
<td>5.63</td>
<td>1.19</td>
</tr>
<tr>
<td>14) I am satisfied with my decision to take this course via Internet.</td>
<td>5.80</td>
<td>1.04</td>
</tr>
<tr>
<td>15) If I have an opportunity to take another course via Internet, I would gladly do so.</td>
<td>6.14</td>
<td>0.99</td>
</tr>
<tr>
<td>16) I feel that online learning served my needs well.</td>
<td>5.87</td>
<td>1.102</td>
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## Appendix B: Principle component analysis and factor loading

<table>
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<td>OSE</td>
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<td>OSE1</td>
<td>0.739</td>
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<td>OSE2</td>
<td>0.815</td>
<td>0.725</td>
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<tr>
<td>OSE3</td>
<td>0.670</td>
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<tr>
<td>OSE4</td>
<td>0.838</td>
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<td>OSE5</td>
<td>0.793</td>
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<td>PEOU</td>
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<td>PEOU1</td>
<td>0.788</td>
<td>0.309</td>
<td>0.805</td>
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<td>PEOU2</td>
<td>0.833</td>
<td>0.395</td>
<td>0.777</td>
<td>0.591</td>
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<tr>
<td>PEOU3</td>
<td>0.819</td>
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<td>PU1</td>
<td>0.863</td>
<td>0.752</td>
<td>0.797</td>
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<tr>
<td>PU2</td>
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<td>0.801</td>
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<td>0.806</td>
<td>0.639</td>
<td>0.455</td>
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<td>PS3</td>
<td>0.851</td>
<td>0.738</td>
<td>0.847</td>
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<tr>
<td>PS4</td>
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<td>0.847</td>
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<td>PS5</td>
<td>0.852</td>
<td>0.832</td>
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Variance %

|        | 21.6 | 18.8 | 16.2 | 12.8 |

Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 6 iterations.
Loading less than 0.3 was omitted.
As the wake left by ever-improving technology is felt throughout education, Hayes Jacob, Ed.D, gathers current thinkers in the field to provide, Contemporary Perspectives on Literacy, in her four volume series. For those interested in the digital education revolution, Mastering Digital Literacy, seeks to close the gap between the digital literacies students use in and outside of school. Hayes employs the help of Marie Alcock; Michael L. Fisher; Steve Hargadon; Bill Sheskey; and Silvia Rosenthal Tolisano to provide practitioners with curriculum applications that meet the demands heard by digital natives in our current school systems.

With five chapters in all, this volume provides readers with need-to-know information, leaving out unnecessary educational jargon, allowing a clear and straightforward read, perfect for busy educators. Chapter One, Digital Masters: Becoming a Blogmaster, Annotexter, or Web Curator, examines the importance of web-design, and its implications to student learning in primary and secondary learning institutions. Chapter Two, Six Curriculum Actions for Developing Digitally Literate Learners, seeks to provide a concrete definition to digital literacy. This chapter provides six implications for curriculum design which adhere to digital literacy competencies found in the Common Core State Standards. Chapter Three, Notes From the Revolution: Peer-Driven Social Learning Communities, dives into the various structures found in digital learning environments. This chapter invites educators into the virtual spaces in which students learn, share, and experience academic content with themselves and one another. Chapter Four, Gaming as Literacy: An Innovation, is the most informative chapter for two simple reasons. First, it explains how the act of playing a video game may require its participant to use many of the same set of skills needed to participate in any literary experience. Second, it justifies the need for educators to believe that video games should be employed to teach a wide variety of literary skills in a whole new way. Chapter Five, The Classroom Website: A Marketplace for Learning, addresses the rationale behind creating digital learning clearinghouses and marketplaces where students can access digital literacies beyond the confines of the classroom.

Mastering Digital Literacy encourages practitioners to walk-a-mile in the shoes of the millennial generation, thus asking educators to empathize with students’ use of digital literacies outside of school. Paralleling these student experiences outside of school with in-school activities is the central motif found in all five easy-to-read chapters. Contributing authors argue that digital literacies found in many of the activities that students already participate in outside of school need to be included in everyday classroom curriculum.

The perspectives and curricular suggestions found in this book are easily understood, and most educators will find themselves critically thinking about how to put these curricular suggestions to work. Supplemental resources are found in every chapter to assist the educator in their inquiries; however, not all web links in the book work. Dead and
unpopulated website references in some of the chapters will most likely frustrate the reader, and gently question the book’s integrity as a real contribution to the field of study. The ideologies presented are clear and provide a common ground for both the educator and student, but they fail to provide the scaffolding needed to support such ideas in the first place. While riding the wake of presented ideas in this book, educators may often find themselves asking, “Great, but how?”

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