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Investigating the Enabling Role of Web 2.0 Technology for Interactive E-learning in Australia

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Abstract

Web 2.0 technology has caught much attention in e-learning due to its interactive nature, ease of use and readily availability. The extent to which web 2.0 technology supports interactive e-learning is however unclear. To adequately address this issue, this paper investigates the extent to which web 2.0 technology supports interactive e-learning and how web 2.0 technology influences the effectiveness of e-learning. Structural equation modelling is used for validating a proposed conceptual model using the survey data collected from Australia. The results reveal that web 2.0 technology supports personal knowledge management, collaboration, instructional support and management of learning resources. Furthermore the results also show that the use of web 2.0 technology for collaboration and management of learning resources positively influences the effectiveness of e-learning.

Keywords

Interactive e-learning, web 2.0 technology, structural equation modelling

INTRODUCTION

E-learning is usually referred to as the application of information and communication technologies for teaching and learning (Wangpipatwong and Papasratorn 2007). It offers many benefits such as providing opportunities for anytime and anywhere learning, self-regulated learning, reducing costs, and expanding access to education (Volery and Lord 2000; Selim 2007). As a result, e-learning is becoming increasingly popular in higher education worldwide (Selim 2007; Sridharan et al. 2010).

Pedagogy and technology are the two pillars of e-learning (Sridharan et al. 2008). Numerous pedagogical approaches such as interactive learning and problem based learning are used in e-learning for enhancing its effectiveness (Sridharan et al. 2008). The use of such pedagogical approaches has positively influenced the effectiveness of e-learning in particular by enabling learners to develop their knowledge and skills independently (Alavi 1994). The provision of effective e-learning, however, is very much dependent on the adoption of effective and innovative technologies for teaching and learning (Sridharan et al. 2008).

With the rapid development of information and communication technologies, numerous technologies such as artificial intelligence (Craig et al. 2004), semantic web (Sridharan et al. 2010), virtual worlds (Duncan et al. 2012), and web 2.0 technology (O'Rilley 2005) have been adopted in e-learning. Such technologies offer numerous opportunities for improving the effectiveness of e-learning. For example, artificial intelligence technologies can be used for helping learners to actively interact with learning systems that mimic instructors and obtain feedback (Craig et al. 2004). Semantic web can be used for enabling learners to effectively interact with learning resources by facilitating customized searching (Sridharan et al. 2010).

Much research has been done for investigating how different pedagogical approaches can be used for improving the effectiveness of e-learning (Alavi 1994). Less attention, however, is paid on how emerging technologies can positively influence the effectiveness of e-learning by supporting predominant pedagogical approaches (Laurillard 2010). New technologies are being introduced in e-learning at a rapid pace. It is difficult to evaluate the potential of such technologies for e-learning (Laurillard 2010). As a result the enabling role of many educational technologies with relevance to pedagogical approaches remains uncovered (Duncan et al. 2012).

Web 2.0 technology refer to a portfolio of web-based tools that help users to create and share content, collaborate and network with other users, and access information seamlessly (O'Rilley 2005; Bates 2010). Blogs, wikis, social bookmarks and YouTube are examples of the popular web 2.0 tools. The introduction of web 2.0 technology provides many opportunities for improving the effectiveness of e-learning with many benefits such as helping learners to learn independently and regulate their learning (Du and Wagner 2007).

Interactive e-learning is an effective approach for developing the knowledge and skills of learners. Existing research has investigated how different technologies could benefit interactive e-learning. How web 2.0

technology could be effectively used for interactive e-learning however is unclear. To address this gap, this paper presents an investigation of the extent to which web 2.0 technology supports the four critical success factors of interactive e-learning. A conceptual model is proposed for interactive e-leaning with the adoption of web 2.0 technology. Structural equation modelling (SEM) is used for testing and validating the proposed model using the survey data collected in an Australian university. The study reveals that web 2.0 technology positively support personal knowledge management, collaboration, instructional support and management of learning resources which are vital for developing interactive e-learning. Furthermore, it reveals that effectiveness of e-learning is positively influenced when web 2.0 technology is used for collaboration and management of learning resources.

In what follows, existing literature on the application of technologies in interactive e-learning is reviewed, leading to the development of a web 2.0-based conceptual model for interactive e-learning. The proposed model is tested and validated using SEM. Finally the research findings and their implications are presented.

RELATED LITERATURE

Interactions refer to the reciprocal events between humans, or between humans and none-humans where mutual influences take place as a result of the events (Wagner 1994). In interactive e-learning, learners actively engage in three types of interactions namely learning resource based interaction, instructor based interaction and peer based interaction which positively influence the effectiveness of e-learning (Moore 1989). Learning resource based interaction refers to the interactions between learners and learning resources (Moore 1989; Sabry and Boldwin 2003).Such interactions positively influences the development of learners' knowledge and skills such as critical thinking and reflection (Wagner 1994). Instructor based interaction is about the exchange of information and communication between learners and instructors in specific environments for obtaining expertise, feedback and encouragements in learners' developments of knowledge and skills (Berge 1998).Interacting with instructors is critical for learners to achieve learning objectives (Selim 2007). Furthermore, they positively influence learners' satisfaction with e-learning (Fuller and Moreno 2004).Peer based interaction focuses on the collaboration between learners in e-learning (Alavi 1991). They assist learners in socially constructing their knowledge and developing skills such as negotiating, communicating and teamwork (Alavi 1994).

There are several critical success factors of interactive e-learning from the perspective of e-learning systems including the management of learning resources, personal knowledge management, instructional support and collaboration. Effectively managing learning resources helps learners to actively explore and discover learning resources that are needed to develop their skills and knowledge (Sridharan et al. 2010). Facilitating personal knowledge management allows learners to collect and interact with none-course resources in particularly by performing tasks such as creating representations of knowledge and organizing information for developing learners' knowledge (Liu 2011). Facilitating the delivery of instructional support provides instructors with facilities to interact with learners to provide them with a wide range of support including content expertise, encouragement and feedback in learning (Berge 1998). Facilitating collaboration enables learners to interact with peers to share ideas, perspectives and resources for achieving academic goals (Alavi 1994).

Different technologies such as artificial intelligence, semantic web, and web 2.0 technology are widely used in interactive e-learning. Much research has investigated the extent these technologies support interactive e-learning and how these technologies influence the effectiveness of e-learning. For example, Sridharan et al. (2011) investigate how semantic web could be used for effectively managing learning resources in e-learning. The above study reveals that semantic web technology can enable learners to actively interact with learning resources by searching and reusing learning resources. Furthermore, it shows that the use of semantic web technologies for learner-learning resources interactions could positively influence the effectiveness of e-learning by improving learners' knowledge and skills. Petrakou (2010) finds that virtual worlds are effective in facilitating synchronous communication among learners in e-learning.

Among numerous technologies being used for interactive e-learning, web 2.0 tools have caught special attention due to their user friendliness, readily availability, low cost and the ability to develop a wide range of skills. Existing research shows that web 2.0 technology could support managing personal knowledge, collaborative writing and provision of peer feedback. For example, Du and Wagner (2007) reveal that blogs are useful for learners to create and archive their personal knowledge. Furthermore, it is shown that using blogs for managing personal knowledge in this manner could increase the learners' ability to meet learning outcomes. Liu (2011) also finds that web 2.0 technology is suitable for managing personal knowledge of learners in higher education. Du and Wagner (2007) show that blogs could be used for collaboration between learners in particular by providing feedbacks to peer learners. Wheeler et al. (2010) investigate how web 2.0 technology could be used for collaborative writing. However, whether using web 2.0 technology for collaboration influences the effectiveness of e-learning is unclear. In addition, there is a scarcity of empirical evidences on the extent to which web 2.0 technology could be used for providing instructional support and managing course learning resources. Furthermore, whether using web 2.0 technology for managing personal knowledge, collaboration, instructional support and management of learning resources influences the effectiveness of e-learning is not much clear.

A CONCEPTUAL MODEL

This study aims to investigate the enabling role of web 2.0 technology in interactive e-learning in Australian higher education. In order to achieve this goal, the research question for this study is formulated as "To what extent does the web 2.0 technology support the critical success factors of interactive e-learning in Australian higher education for effective e-learning?"

To adequately answer the research question, a conceptual model is developed as in Figure 1. The conceptual model hypothesizes that web 2.0 technology positively supports personal knowledge management (Liu 2011; Dabbagh and Kitsantas 2011), collaboration (Shee and Wang 2000), instructional support (Berge 1998) and management of learning resources in interactive e-learning (Sridharan et al. 2010). It further hypothesizes that the effectiveness of e-learning is influenced by using web 2.0 technology for personal knowledge management, collaboration, instructional support and management of learning resources (Hsu et al. 2009).

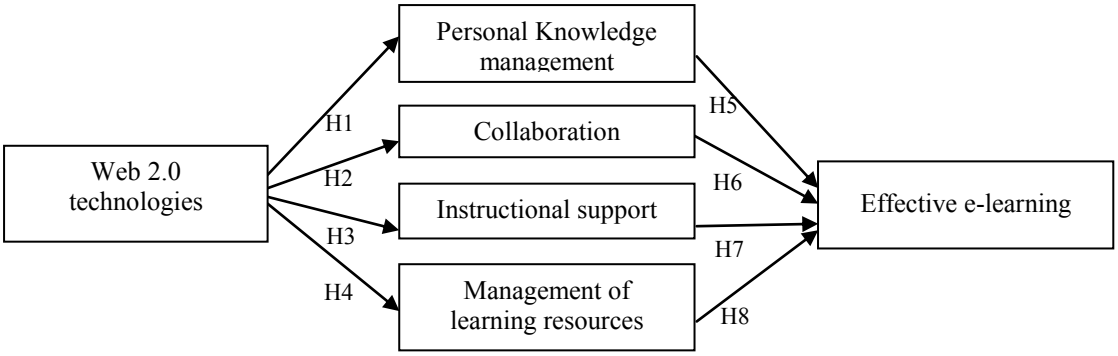

Figure 1. A web 2.0 based conceptual model for developing interactive e-learning

Web 2.0 technology refers to a portfolio of web based tools and services that facilitate content creation, content sharing, content manipulation, collaborative authoring and etc. (O'Rilley 2005; Bates 2010). They are increasingly being used in e-leaning in particular due to their ease of use (Hsu et al. 2009). Web 2.0 tools such as blogs, YouTube and social bookmarking are helpful for learners to create and manage information and resources of multiple types effectively. For example blogs are helpful for creating, organizing and archiving content (Du and Wagner 2009; Hsu et al. 2009). Social bookmarking is helpful for learners to classify, organize and manage bookmarks of web based resources effectively (Hsu et al. 2009).

Content sharing and collaboration are two major capabilities of web 2.0 technology (Schneckenberg et al. 2011). Web 2.0 tools such as YouTube and social bookmarking could be used for sharing content such as audios, videos and bookmarks of web based resources among learners in a convenient manner (Hsu et al. 2009; Bates 2010). In addition, blogs and Internet Messengers could be used to communicate synchronously and asynchronously. Furthermore, blogs allows learners to share content, and to provide feedback on shared content (Du and Wagner 2007). Wikis allows learners to collaboratively add, edit and manage content (Wheeler et al. 2010). Based on the above discussion following hypotheses are formulated in the following

H1: Web 2.0 tools can positively support personal knowledge management

H2: Web 2.0 tools can positively support collaboration

Web 2.0 tools such as podcasts, Slideshare and Elluminate could be used by the instructors to deliver lectures to learners (Bates 2010). Furthermore, web 2.0 tools such as blogs and wikis can be used as authentic assessment tools for assessing the artefacts produced by learners as well as learners' processes of learning (Ching and Hsu 2010). In addition, web 2.0 tools such as blogs and YouTube could be used by instructors to review the work of learners and provide feedbacks (Du and Wagner 2007; Bates 2010).

Web 2.0 tools such as blogs, YouTube and social bookmarking are also used for developing repositories of learning resources (Du and Wagner 2007). A new generation of web 2.0 based learning resources repositories such as TeacherTube and MERLOT are emerging based on web 2.0 technology. These learning resources repositories are in particular attractive due to the ease of searching, sharing and reusing resources in them. Based on the above discussion, the following hypotheses are formulated.

H3: Web 2.0 tools can positively support the provision of instructional support for effective e-learning

H4: Web 2.0 tools can positively support the management of learning resources for effective e-learning

Personal knowledge management refers to the process of managing one's knowledge by recording, maintaining, classifying, organizing and integrating different contents where learners interact with non-course resources

effectively to meet their learning goals (Liu 2011). It is useful for learners to develop their personal knowledge bases for assisting them to meet their learning outcomes (Du and Wagner 2007). Managing personal knowledge in such a manner is helpful for learners to regulate their learning as well as to develop their competencies. These competencies include skills of problem solving, reflecting and analysing (Alexiou and Paraskeva 2010). Based on this discussion the following hypothesis is formulated:

H5: Effectively managing personal knowledge using web 2.0 tools positively influences the effectiveness of e-learning

Collaboration refers to effective interactions taking place between learners for meeting learning goals (Volery and Lord 2000; Shee and Wang 2000). Such interactions may involve in exchanging ideas and resources (Shee and Wang 2000). Collaboration between learners is helpful for constructing their knowledge socially. In particular, exchanging ideas and perspectives assists learners to evaluate their understandings and reveals their misconceptions. Collaboration between learners in e-learning helps learners to better achieve learning outcomes and enhance their satisfaction (Alavi 1994; Volery and Lord 2000; Shee and Wang 2000). Based on the above discussion following hypothesis is proposed:

H6: Collaboration in the learning community using web 2.0 tools positively influences the effectiveness of e-learning

Instructional support refers to the interactions between instructors and learners in terms of providing feedbacks, encouragement, and design of interactive activities (Berge 1995). Even though e-learning requires a higher degree of independent learning, obtaining adequate support from instructors is still critical (Bates 2010). In particular, instructors have a significant role in directing learners towards achieving the learning objectives (Bates 2010). Existing research shows that instructional support leads to a higher degree of perceived satisfaction for learners, leading to the improvement of the effectiveness of e-learning (Volery and Lord 2000; Selim 2007). Based on the above discussion following hypothesis is proposed:

H7: Instructional support delivered with web 2.0 tools positively influences the effectiveness of e-learning

The management of learning resources refers to maintaining and presenting learning resources in a more usable and attractive manner for facilitating learners to effectively interact with learning resources to meet their learning goals (Sridharan et al. 2010). Characteristics such as attractive presentation styles, support of the maintenance of multiple types of resources, support of searching resources and support of sharing resources are critical in e-learning (Sridharan et al. 2010). In particular, the ability to search resources and the ability to share resources are helpful for learners to actively search, locate and use the existing learning resources for achieving their academic goals. Furthermore, the availability of learning resources in multiple types assists learners with different learning styles to learn the learning resources more effectively (Karagiori and Symeou 2005). Effectively managing learning resources in a usable manner leads to the satisfaction of learners (Sridharan et al. 2010). Based on the above discussion following hypothesis is proposed:

H8: Management of learning resources with web 2.0 tools positively influences the effectiveness of e-learning

RESEARCH METHODOLOGY

To adequately answer the research question in this research, a quantitative approach is adopted, based on two reasons. Firstly, a quantitative approach could test the relationship between variables and explaining the relationships between the variables in the proposed theory with the use of numeric data (Neuman 2007). Secondly, a quantitative approach allows collecting data from a large number of respondents and therefore generalizing the results of testing the proposed theories to a larger population (Cresswel 2007).

A survey is conducted to collect the data needed to test and validate the conceptual model. The survey instrument designed to collect data comprises of two sections including the demographic information of learners and the perceptions of learners on the use of web 2.0 technology for interactive e-learning. The demographic information includes age, gender, field of study, and level of study of learners. A total of 36 questions are included in the survey corresponding to the measurement items measuring the theoretical constructs. Table 1 summarises the variables chosen for measuring the theoretical constructs in the conceptual model in Figure 1. These measurement items are selected from research instruments used in previous research to measure similar constructs. The respondents of the survey are required to select an answer for these questions from a seven-point Likert-type scale where 1 in the scale represents Strongly Disagree and 7 in the scale represent Strongly Agree.

Prior to the distribution of the questionnaire, a pilot study is carried out to determine the appropriateness of the questions in the questionnaire. A total of 20 higher educational learners from different fields of studies participated in the pilot study. Based on the feedback received on the clarity and appropriateness of the questions from the pilot study the survey is revised. The survey is printed and distributed among 600 learners in RMIT University in Australia. A total of 202 respondents have responded to the survey with a response rate of 35%.

Table 1. Summary of the measurement variables

Construct	Sample measurement variables	No. of Items	Pertaining Literature
1 Personal knowledge management (PKM)	Recording content	5	Lau and Tsui (2009),
	Integrating content		Hsu et al. (2009)
2 Collaboration (COL)	Discussing with peers	5	Shee and Wang (2006),
	Sharing learning resources		Du and Wagner (2007)
3 Instructional Support (INS)	Encouraging of collaboration	6	Velery and Lord (2000),
	Providing feedback		Selim (2007)
4 Management of learning resources (LRS)	Availability of resources in multiple types Availability of reusable resources	5	Karagiori and Symeou (2005), Sridharan et al. (2010)
5 Web 2.0 technology (WEB)	Technologies facilitating sharing content	10	McLoughlin and Lee (2007), Du andWagner (2007)
	Technologies facilitating co-authoring		
6 Effective e-learning	Critical thinking skills	5	Du and Wagner (2007)
	Meeting learning outcomes		Sridharan et al. (2010)

Table 2 presents the gender and level of study profile of the respondents to the survey. Of the participants 64 are male students whereas 36% of the participants are female students. Of the participants 51% are learners enrolled in undergraduate programs whereas 49% of the respondents are enrolled in post-graduate programs. The respondents study in different fields including Business studies, Engineering, Arts, Computer Science, Information Technology, and Science and Health.

Table 2. Distribution of gender and level of the respondents

	Gender		Level of study	
	Male	Female	Undergraduate	Postgraduate
1 Respondents	129	73	103	99
2 Percentage	64%	36%	51%	49%

The proposed conceptual model in Figure 1 is tested and validated using SEM (Hair et al. 2010). SEM is a collection of statistical techniques comprising factor analysis and multiple regression analysis, which is capable of examining multiple relationships between constructs simultaneously (Hair et al. 2010). It is suitable in this study for data analysis due to several reasons. Firstly, it allows users to hypothesize a model with a series of causal relationships among multiple variables, and validate such relationships simultaneously. Secondly, SEM is capable of estimating the relationship between the latent variables available in the theoretical model. Thirdly, the indirect effects of web 2.0 technology on the effectiveness e-learning in the theoretical model can be easily evaluated using SEM (Hair et al. 2010).

The SEM analysis is conducted in two steps namely developing and validating a measurement model, and testing and validating a structural model (Hair et al. 2010). The measurement model shows how the theoretical constructs in the conceptual model are related to the measurement variables for measuring the constructs (Hair et al. 2010). SEM uses confirmatory factor analysis (CFA) for assessing the measurement model. Assessing the measurement model using CFA examines how well the measurement variable used to measure the theoretical constructs represents the theoretical construct (Hair et al. 2010).

The validity of the measurement model is assessed by examining its fitness. The overall fitness of the measurement model is assessed using different goodness-of-fit (GOF) indices. Those GOF indices are helpful to assess the extent to which the theory specified with the conceptual model is represented by the collected data (Hair et al. 2010). Using multiple GOF indices is considered suitable for assessing the fitness of measurement models (Hair et al. 2010). Following the recommendation of Hair et al. (2010) in this research the Chi-square statistic ($\chi 2$), the Normed Chi-Square ($\chi 2$/ df), the Goodness of Fit Index (GFI), the Tucker-Lewis Index (TLI) and the Root mean square error of approximation (RMSEA) are used for assessing the fitness of the model.

The $\chi 2$, $\chi 2$/ df, GFI and RMSEA are considered as the absolute fit indices which compare how well the sample data fit the theoretical model (Hair et al. 2010). The $\chi 2$ is the most basic GOF index. With the chi-square value, the probability (p) that the observed covariance matrix and estimated covariance matrix are equal is also estimated. A lower $\chi 2$ value with a larger p value is considered appropriate to demonstrate better fitness (Hair et al. 2010). $\chi 2$/df is another goodness-of-fit index used for assessing the fitness of the theoretical models. For a better fitness of the model the value of $\chi 2$/df is expected to be lesser than 3. GFI is another GOF index that could be used to overcome the limitation of the sensitivity for large samples in measurements which is a problem with $\chi 2$ goodness-of-fit index. A GFI value greater than 0.9 is an indication of a good-fitness of the model (Hair et al. 2010). RMSEA is a much used measure at present as a solution to the sensitivity of $\chi 2$ for large samples, and the complexities of models. A RMSEA value of 0.08 or lower is considered as an indicator of an acceptable fitness (Hair et al. 2010). TLI is an incremental fit index. Incremental fit indices assess the fitness of a model compared to a baseline model which assumes that the observed variables in the model are uncorrelated. A TLI value greater than 0.95 is considered as suitable for the model fitness (Hair et al. 2010).

On assessing the measurement model and obtaining an appropriate fitness of the measurement model, the structural model is developed and assessed. The structural model is used to reveal whether the dependence relationships specified in the conceptual model between constructs are valid (Hair et al. 2010). It contains theoretical constructs and their relationships as specified in the conceptual model. Evaluating the structural model is done for examining whether the specified structural model is valid. Furthermore, it is useful to determine the extent to which each specified relationship is supported by examining their statistical significance.

DATA ANALYSIS AND FINDINGS

The full measurement model in this research is developed and validated using SEM. To examine whether the measurement model is valid, the goodness-of-fit of the overall model is assessed (Hair et al. 2010). The values of the goodness-of-fit indices resulted from the assessment of the full measurement model show that the overall fitness of the measurement model is inadequate. To improve the fitness of the full measurement model, one factor congeneric models are re-examined and re-specified for improving their fitness.

Re-specifying the congeneric measurement model for improving their fitness is done by considering the standard factor loading (SFL) of the measurement variables, standard residuals and modification indices (Hair et al. 2010). In particular, those measurement variables with the SFL less than 0.5 and the standard residuals greater than |2.5| are considered suitable for deletion from the models to improve the fitness of the model. Following this criterion a few measurement variables are deleted from the congeneric measurement models. The constructs of the full measurement model are modified to reflect the modifications done in those congeneric measurement models.

To assess the validity of the final measurement models, the construct validity of the constructs and the goodness-of–fit of the models are examined. Construct validity refers "to the extent to which the measurement variables actually represents the theoretical constructs" (Hair et al. 2010, p. 661). In this research discriminant validity and the convergent validity of the constructs are examined to assess the validity of the constructs.

The discriminant validity is used to determine the distinction of the constructs from each other (Hair et al. 2010). The discriminant validity between two constructs could be determined by comparing squared correlation between the constructs with the AVEs of the constructs. The AVEs of the constructs should be higher than the squared correlation for adequate discriminant validity. A summary of the discriminant validity of the constructs in the final measurement is shown in Table 3. The squared correlations between the constructs in the table are shown across the diagonal of the table.

Table 3. Discriminant validity of the constructs in the final measurement model

	PKM	COL	INS	LRS	WEB	EFT
PKM	0.504					
COL	0.307	0.492				
INS	0.254	0.340	0.653			
LRS	0.351	0.323	0.630	0.649		
WEB	0.175	0.349	0.380	0.354	0.622	
EFT	0.080	0.247	0.298	0.391	0.375	0.616

The convergent validity is used to determine the degree to which the indicators of a construct converge. Three estimates namely the standardized factor loading (SFL), the average variance extracted (AVE), and the construct reliability (CR) are used in this research to assess the convergent validity of the constructs (Hair et al. 2010). A

SFL of 0.5 or higher of an item indicates that the item converges on the construct, and therefore is considered as having the convergent validity (Hair et al. 2010). As a good rule of thumb, AVE of a construct should be at 0.5 or higher to have a higher convergence (Hair et al. 2010). The convergent validity measures for the final constructs measured using standard factor loadings and AVE are shown in Table 4. Table 4 also includes the reliability measures for the constructs in the scale calculated using Cronbach's Alpha. The Cronbach's Alpha exceeding 0.7 indicates that the reliability of the instrument is adequate.

Table 4. Convergent validity of the constructs of the final measurement model

Construct	Alpha	AVE	Indicator	Variable	SFL
Personal knowledge management (PKM)	0.752	0.504	Creating/recording content	PKM1	0.699
			Classifying content	PKM3	0.693
			Organizing content	PKM4	0.737
Collaboration (COL)	0.746	0.492	Discussing with peers	COL1	0.724
			Sharing resources	COL3	0.671
			Accessing shared resources	COL4	0.708
Instructional support (INS)	0.790	0.653	Teaching style	INS1	0.808
			Diversity of activities	INS2	0.808
Management of learning resources (LRS)	0.846	0.649	Presentation style	LRS1	0.803
			Ability to search	LRS2	0.818
			Ability to share	LRS3	0.796
Web 2.0 technology (WEB)	0.836	0.622	Technologies supporting content manipulation	WEB4	0.663
			Technologies supporting sharing content	WEB7	0.743
			Technologies supporting co-authoring	WEB8	0.928
			Technologies supporting commenting and ratings	WEB9	0.798
Effective e-learning	0.812	0.616	Critical thinking	EFT1	0.763
			Meeting learning outcomes	EFT3	0.881
			Obtaining good grades	EFT4	0.699

Table 5 shows the GOF results for the one factor congeneric models and the final full measurement model. The GOF indices results included in the table are the chi-square ($\chi 2$), $\chi 2$/ df, GFI, TLI and RMSEA. The results demonstrate that all the resulted values are within the acceptable ranges for GOF indices.

Table 5. Goodness-of-fit results for the initial and final measurement models

Construct	$\chi 2$	P	$\chi 2$/df	GFI	RMSEA	TLI
Personal Knowledge Management (PKM)	0.008	0.928	0.008	1.000	0.000	1.033
Collaboration (COL)	1.415	0.234	1.415	0.993	0.056	0.986
Instructional support (INS)	0.080	0.778	0.080	0.999	0.000	1.013
Management of learning resources (LRS)	0.304	0.581	0.304	0.998	0.000	1.013
Web 2.0 technology (WEB)	1.300	0.522	0.650	0.995	0.000	1.009
Effective e-learning	0.028	0.868	0.028	1.000	0.000	1.020
Full measurement model	129.3	0.264	1.078	0.907	0.024	0.989
Recommended values		>0.05	<3.00	>0.900	<0.08	>0.950

The structural model is developed after the successful validation of the measurement model, shown as in Figure 2. The evaluation of the structural model reveals that H1, H2, H3, H4, H6 and H8 are supported while H5 and H7 are not supported. In particular, the support for H1, H2, H3 and H4 is strong with path coefficients of 0.491 ($p<0.001$), 0.644 ($p<0.001$), 0.683 ($p<0.001$) and 0.882 ($p<0.001$) respectively. Comparatively, H6 ($p<0.05$) and H7 ($p<0.001$) are less supported but still significant. The relationships shown in COL → EFT, and LRS→ EFT are exemplified by the coefficient values of 0.149 and 0.338 respectively.

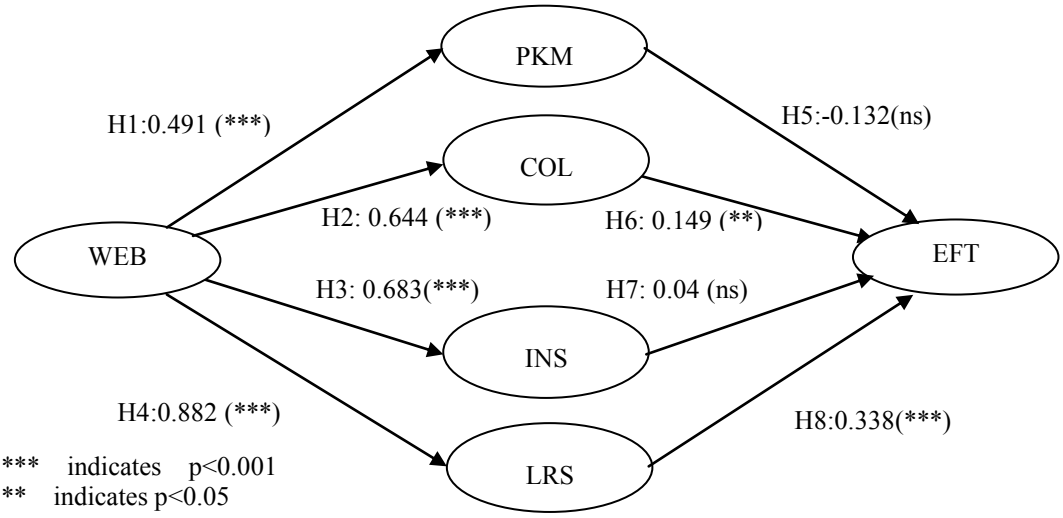

Figure 2. The structural model

Based on the analysis above, this research shows that web 2.0 technology supports personal knowledge management. Such a finding implies that web 2.0 technology could facilitate learner-non-course learning resources interactions. Similar to this research, studies done by Du and Wagner (2007) and Liu (2011) reveal that web 2.0 tools support personal knowledge management, in particular, by assisting learners to create, organize and aggregate information and resources.

Results of this research also show that web 2.0 technology supports collaboration in interactive e-learning. This means that web 2.0 tools could be used for facilitating learner-learner interactions. The results of this research, in particular, find that the capabilities of web 2.0 tools in sharing content, commenting and rating which enable learners to share content, communicate and write collaboratively are attractive. Similar to this research, Wheeler et al. (2008) and Du and Wagner (2007) also find that web 2.0 tools could be used by learners for provision of peer feedback and collaborative writing.

This research finds that web 2.0 technology supports delivering instructional support. This implies that web 2.0 technology is useful for instructors to interact with learners to provide learning support. Existing research does not discuss in detail the extent to which web 2.0 technology could be used for delivering instructional support. However, a few existing literature including the study by Ching and Hsu (2011) suggest that web 2.0 tools such as blogs could be used by instructors for conducting authentic assessments and providing feedback.

Whether web 2.0 technology could be used by learners for interacting with course learning resources is also not clear in the existing literature. Results of this research, however, show that web 2.0 technology could positively support managing course learning resources. The possible explanation for this finding is that learners find features of web 2.0 tools such as searching, sharing and reusing resources useful and attractive for managing learning resources.

This research also finds that the collaboration and management of learning resources using web 2.0 technology positively influences the effectiveness of e-learning. The above findings imply that using web 2.0 technology for collaboration and management of learning resources would increase learners' satisfaction of e-learning, achievment of learning objectives and development of skills. Although, previous research has revealed that collaboration and management of learning resources influence the effectiveness for e-learning, whether using web 2.0 tools for collaboration and management of learning resources influences the effectiveness of e-learning is not clear in the existing literature.

The relationship between personal knowledge management and the effectiveness of e-learning is shown to be insignificant in the structural model. This indicates that using web 2.0 for personal knowledge management does not positively influence the effectiveness of e-learning. The possible reason for the above finding is that learners find other technologies more effective in managing personal knowledge, and thus,leading to effective e-learning. Another reason for the above finding might be that irrespective of the choice of technology used for personal knowledge management, learners do not perceive the need of finding and managing none-course learning

resources themselves critical for effective e-learning. The relationship between instructional support and the effectiveness of e-learning is also not significant. The possible reason for the insignificant relationship between instructional support and the effectiveness of e-learning is that learners find technologies that they are already familiar with in delivering instructions such as Blackboard more convenient and appropriate than web 2.0 technology in delivering instructional support and thus, lead to effective e-learning. Another reason for the above finding is that the irrespective of the choice of technology for instructional support, learners are not much dependent on the learning support given by instructors which lead to effective e-learning.

CONCLUSION

This paper investigates the enabling role of web 2.0 technology in interactive e-learning in Australia. There are two major implications of this research. Firstly, finding that web 2.0 technology supports personal knowledge management, management of learning resources, instructional support and collaboration in this research implies that web 2.0 technology supports interaction between learning resources, instructors and peer learners in e-learning. The three aforementioned interactions are at the heart of interactive e-learning. The second major implication of this research is that the use of web 2.0 technology for collaboration and management of learning resources could positively influence the effectiveness of e-learning.

This research contributes to the existing literature from both a theoretical view point and a practical view point. Although much existing literature discusses the impact of using different pedagogical approaches on the effectiveness of e-learning, less attention is paid on how emerging technologies could be used relevant to pedagogical approaches and whether applying such technologies influences the effectiveness of e-learning. Specifically examining how web 2.0 technology could be used for interactive e-learning, this research finds that web 2.0 technology could be used to interact with learning resources, instructors and peer learners. Furthermore it is shown that learner-learning resources interactions and learner-learner interactions enabled by web 2.0 technology positively influence the effectiveness of e-learning. From a practical perspective, the findings of this research imply that the web 2.0 technology could be used for providing effective interactive e-learning. This knowledge would be useful for instructors and e-learning developers. In particular, instructors could gain a better understanding of how interactions in an e-learning environment could be enhanced using web 2.0 tools, and use web 2.0 tools to improve the effectiveness of e-learning. E-learning developers could design and develop more interactive e-learning environments using web 2.0 technology based on the findings of this research.

There are several limitations of this research. Firstly, this research considers only a small sample of higher educational learners studying at RMIT University. Therefore, the results of this research may not be generalizable for higher educational learner population in Australia. Secondly this research only considers the perceptions of learners in investigating the enabling role of web 2.0 technology for interactive e-learning. The perceptions of other stakeholders of e-learning such as instructors are not considered.

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REFERENCES

Alavi, M. 1994. “Computer-mediated collaborative learning: an empirical evaluation,” *MIS Quarterly* (18:2), June, pp 159-174.

Bates, T. 2010. “Understanding Web 2.0 and its Implications for E-Learning,” In *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching*. Hershey, PA: IGI Global, pp 21-42.

Berge, Z.L. 1998. “Guiding Principles in Web Based Instructional Design,” *Educational Media International* (35:2), June, pp 72-76.

Craig, S.D., Driscoll, D.M., and Gholson, B. 2004. “Constructing Knowledge from Dialog in an Intelligent Tutoring System: Interactive Learning, Vicarious Learning, and Pedagogical Agents,” *Journal of Educational Multimedia and Hypermedia* (13:2), April, pp 163-183.

Creswell, J.W. 2007. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Sage.

Dabbagh, N., and Kitsantas, A. 2012. "Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning," *The Internet and Higher Education* (15:1), January, pp 3-8.

Du, H.S., and Wagner, C. 2007. "Learning With Weblogs: Enhancing Cognitive and Social Knowledge Construction," *IEEE Transactions on Professional Communication* (50:1), March, pp 1-16.

Duncan, H.E., and Young, S. 2009. "Online Pedagogy and Practice: Challenges and Strategies," *The Researcher* (22:1), pp 17-32.

Hair, J.F., Black, W.C., Babin, B.J., and Anderson, R.E. 2010. *Multivariate Data Analysis*. Englewood Cliffs, New Jersey: Printice-Hall.

Hsu, Y.C., Ching, Y.H., and Grabowski, B. 2009. "Web 2.0 Technologies as Cognitive Tools of the New Media Age," In *Handbook of Research on New Media Literacy at the K-12 Level: Issues and Challenges,* Hershey, PA: IGI Global, pp 353-371.

Karagiorgi, Y., and Symeou, L. 2005. "Translating Constructivism into Instructional Design: Potential and Limitations," *Educational Technology & Society* (8:1), pp 17-27.

Laurillard, D. 2010. "Effective Use of Technology in Teaching and Learning in HE," In *International Encyclopaedia of Education*. Oxford, Elsevier, pp 419-426.

Liu, X. 2011. "Investigation on Students' Personal Knowledge Management and Uses of Web 2.0 Technologies in Chinese Higher Education". Paper presented at the *Southern Association for Information Systems Conference*, Atlanta, USA.

Moore, M.G. 1989. "Three types of interaction," *The American Journal of Distance Education* (3:2), pp 1–6.

O'Reilly, T. 2005. Web 2.0: Compact Definition?. Retrieved 11 July, 2011, from http://radar.oreilly.com/2006/12/web-20-compact-definition-tryi.html

Petrakou, A. 2010. "Interacting through avatars: Virtual worlds as a context for online education," *Computers & Education* (54:4), May, pp 1020-1027.

Sabry, K.., and Baldwin, L. 2003. "Web-based learning interaction and learning styles," *British Journal of Educational Technology* (34:4), September, pp 443-454.

Selim, H.M. 2007. "Critical success factors for e-learning acceptance: Confirmatory factor models," *Computers & Education* (49:2), September, pp 396-413.

Shee, D.Y., and Wang, Y.S. 2008. "Multi-criteria evaluation of the web-based e-learning system: A methodology based on learner satisfaction and its applications," *Computers & Education* (50:3), April, pp 894-905.

Sridharan, B., Deng, H., & Corbitt, B. 2008. "Evaluating Intertwined Critical Success Factors for Sustainable E-learning," *ACIS 2008 Proceedings*. Paper 102.

Sridharan, B., Deng, H., and Corbitt, B. 2010. "Critical success factors in e-learning ecosystems: a qualitative study," *Journal of Systems and Information Technology* (12:4), pp 263-288.

Volery, T., and Lord, D. 2000. "Critical success factors in online education," *International Journal of Educational Management* (14:5), pp 216-223.

Wagner, E.D. 1994. "In Support of a Function Definition of Interaction," *The American Journal of Distance Education* (8:20), pp 6–29.

Wangpipatwong, T., and Papasratorn, B. 2007. "The Influence of Constructivist E-Learning System on Student Learning Outcomes," *International Journal of Information and Communication Technology Education* (3:4), pp 21-33.

Wheeler, S., Yeomans, P., and Wheeler, D. 2008. "The good, the bad and the wiki: Evaluating student-generated content for collaborative learning," *British Journal of Educational Technology* (39:6), pp 987-995.

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