Learning Synchronicity for Learning Performance

Research-in-Progress

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Abstract

Online learning environments facilitate improved communication, better access to learning, and greater student control. Because technology is dynamic in nature continuing improvement to online learning environments is necessary. Extant literature highlights technological and behavioral characteristics influence learning outcomes. However, the combined effects of both technological and human behavioral characteristics in online learning is not yet sufficiently explored. We investigate the role of technological and behavioral characteristics through learning synchronicity on learning performance. Based on the Information System Success model and the Task Technology Fit model we propose a conceptual model showing both technological and behavioral characteristics in a learning environment. Tertiary students participated in the research by reflecting on their online learning experience.

Keywords: Online learning, Task technology fit, Learning synchronicity

Introduction

Technology enabled Online Learning Environments (OLE) are the standard in today's educational institutions. The demand for OLEs is significant as it satisfies institutional needs and much-needed flexibility in learning options for students (Hu & Hui, 2012; Piccoli, Ahmad, & Ives, 2001). OLEs allow access to learning independent of geographical constraints, improve communication, promote equity, and provide greater student control over learning (Oztekin, Delen, Turkyilmaz, & Zaim, 2013; Piccoli et al., 2001). Continued improvements to the design of OLEs are necessary so that OLEs support evolving learning practices (Mueller & Strohmeier, 2011). Even though formal learning management systems (LMSs) are the core of online learning, the growth and the impact of informal systems are significant. Social Networking Applications (SNA) are highly popular for online social networking. Contemporary students often use SNAs for personal needs. SNAs facilitate communication, interaction, and access to online content while providing significant control by the user (Cheung, Chiu, & Lee, 2011; Kane, Alavi, Labianca, & Borgatti, 2014). The developments in mobile technology have further improved the usefulness of the Internet and SNAs. For example, students can access the Internet independent of geographical constraints, and set the use of content as per their preference (Alavi, Marakas, & Youngjin, 2002; Hu & Hui, 2012).

Interaction and communication are necessary characteristics of social networking while access, privacy, and user control are becoming increasingly important in online learning communities (Wan, Compeau, & Haggerty, 2012; Wodzicki, Schwämmlein, & Moskaliuk, 2012). Social learning theory and constructivism show social interaction and communication are necessary characteristics in learning (Arbaugh & Benbunan-Finch, 2006; Bandura, 2001; Cheung et al., 2011). SNAs provide the necessary functionalities of interaction, communication, and access, as well as user control. Accordingly, it is noted that the formal Learning Management Systems (LMS) together with informal learning systems (e.g., SNA) can contribute significantly to learning by facilitating students' learning needs in OLEs.

A review of the existing literature provides limited empirical evidence explaining the role that task, technology, and behavioral characteristics play in achieving learning performance. Research should be conducted to understand the contemporary learning and the technological characteristics affecting learning performance. We use the Information System (IS) Success model and Task Technology Fit (TTF) theory to develop a model showing the role of task, technology, and behavioral characteristics in achieving learning performance through learning synchronicity. Learning synchronicity consists of static fit and dynamic fit. Static fit is the structural fit of the technology while dynamic fit refers to the progressive alignment of the technology towards a common learning objective (Dennis, Fuller, & Valacich, 2008). Accordingly, the overarching research question for this study is, *what synchronization role do task, technological, and behavioral characteristics play in achieving learning performance?*

To investigate the above research question, the research uses the existing literature to develop a research model and tests it by conducting a survey of tertiary students. We show the initial results from the study. Survey data is analysed using SPSS and SmartPLS applications.

Background

Online Learning Environment (OLE)

An OLE is a technologically enabled learning environment that facilitates communication and interactions among participants (Piccoli et al. 2001). Usually students use an educational institution managed formal LMS augmented by the informal uses of social networking applications (Ferguson 2012; Steiner et al. 2013). When using either LMS or SNA, students access the system through the internet while managing the learning by themselves. The learning occurring with the help of SNAs often occurs informally and as such, the exact role of the use of SNAs in learning is not entirely known. However, access, control, and communication are core attributes of SNAs and they are necessary characteristics for students' learning. These characteristics are further improved with the development in technologies such as mobile technology and smart phones. Therefore, in the context of learning, the key factors, task (the learning task), technology (the learning information and the system), and behavior (learning related students behavior) are explored in this research (Goodhue & Thompson, 1995; Kim & Ammeter, 2014). It must be noted that the decision to use a specific learning system is influenced by the users' behavioral and the systems' technological characteristics (Hu and Hui 2012; Santhanam et al. 2008). Students use these systems with the expectation that the system will help their learning. In summary, learning expectations of the contemporary students must be supported by the technology to achieve the learning performance.

Task Technology Fit (TTF)

Task technology fit (TTF) states that the system will help improve user performance when the technology is a good fit for the task it supports (Goodhue & Thompson, 1995). The technology in this research is the information system used for learning. Therefore, the extent of the usefulness of the information, and the system for learning, indicates the fitness for the task. The better the system is at satisfying the needs of the learning tasks, the better the learning performance. The extent of the usefulness of the information and the system for learning indicates the extent of the fit. Therefore, fit is necessary for improved learning performance. Thus, fit is viewed as a mediating factor for learning performance.

Learning requires, the information, the system, and the users to work jointly to achieve task performance. For example, when the information is available, the students must be able to use it. The systems are able to facilitate the information availability. The students can use the system enabled information to progress learning. Therefore, the availability of the information and/or the system could indicate the static aspect of the fit. In such context, the information, system, and the human work collaboratively towards a common goal in learning (Piccoli et al., 2001). Behavioral factors must be included when assessing the online learning as they are a necessary part of the learning (Piccoli et al., 2001). Additionally, the technology refers to the information and the system while the learning task refers to the attention, retention, and production (Jin, Li, Zhong, & Zhai, 2015). Attention, retention, and reproduction are sequentially and progressively executed during learning which indicates the progression in learning. Such progression is referred to as a dynamic fit for this research. The dynamic aspect of the fit therefore could be indicated by the usefulness of the information, system, and behavior to complete a learning task.

Synchronicity

Synchronicity refers to the process (eg: learning task) of the technology and human (behavior) collaboratively working to achieve a common goal (Dennis et al., 2008; Johnson, Gueutal, & Falbe, 2009). The synchronicity is of two dimensions consisting of static fit and dynamic fit. Static fit refers to the structural nature of the fit while dynamic fit refers to the progressive learning. The structural nature of the fit is measured by assessing the information and the systems availability. Dynamic fit is measured by assessing the usefulness of the learning process. Students identify the extent of the usefulness of the characteristic to complete learning tasks. Collaboration can be achieved when the technology is able to support students' learning needs. During learning students go through progressive learning processes. The student must be able to complete the learning task and progress in learning with the help of the technology. The technology, therefore, must provide the necessary functionality which can be utilized by the learner. Availability of such functionality is an indication that the technology fits students' needs which is identified as the "static fit", one of the dimensions in synchronicity. Having the technology that can be useful to complete a task doesn't mean the technology is useful for learning performance. The technology must be properly used to complete learning tasks. When the technology is successfully used to complete the learning task, the technology is useful to progress in learning. This process is defined as the "dynamic fit". Accordingly, the static fit and the dynamic fit in learning are referred to as the learning synchronicity. The synchronicity is a mediating factor during learning as the synchronicity is a necessary factor in achieving the learning performance.

Research Development

Conceptual Development

OLEs consist of the technology and the people who use the environments for learning. OLEs are facilitated by the learning functions provided through systems and the information they contain. Educational institutions use these online systems (referred to as LMSs) to provide educational services including learning information, learning paths, and related functionalities to students. Examples of LMSs are *Blackboard* and *Moodle*. Instructors create learning spaces for specific subjects and then create learning paths to achieve learning objectives allowing students to progressively learn by completing learning activities along the learning path. When using these LMSs, creating suitable learning processes, providing suitable information for students, and facilitating access to the system for students are some of the critical factors in students' learning. Usually instructors control the functionalities available through LMS for students.

Students, however, also use SNAs to support their learning. Use of informal systems has become popular among contemporary learning. The choice and the use of informal systems could vary per individual student. For example, factors such as student's previous experience of the system and the conformity could influence the decision to use the system (Ma & Agarwal, 2007). In summary, the learning, the information, the system (either formal or informal), and the student are important factors in online learning today. Accordingly, this research investigates the learning process, system, and behavioral characteristics as independent variables.

The technology must match the needs of the task executed by users to achieve the task performance (Goodhue & Thompson, 1995). Learning requires information to be shared among participants in the learning process where the knowledge expert communicates the information to the student (Leidner & Jarvenpaa, 1995; Shell & Janicki, 2012). Thus, learning systems must be able to facilitate information transfer between participants. Students expect the information to be available when they need it. The immediacy of the information, usefulness of the information, relevance, and sufficiency of the information are some of the characteristics that are necessary for better learning. When the required information is available and the learning system is able to provide the necessary learning services, students can progress in learning without delay. Such progress could help students to learn better and reflect their learning during summative assessments. In summary, availability of the learning system and the availability of the useful information are referred to as "static fit".

When students are able to progress in learning with the help of the information and the learning system, it is viewed that the information, system, and the students are collaborating towards the common learning goal. Because, students' aim of the use of the system is to complete a learning task the system must provide the necessary information and processes to complete the learning task. The three factors, namely information, system and the student, act towards the same objective (collaboratively), which is identified as "dynamic fit". The extent of the three factors (task, technology, student) progressing towards the same objective is viewed as the extent of the "dynamic fit". The dynamic fit is defined as all participants in a process, progressing towards a common goal. The structural aspect of the technology and the behavior working together is viewed as the *static fit* while the dynamic aspect of the technology and the behavior working together is referred as the *dynamic fit*. Accordingly, the *static fit* and the *dynamic fit* are necessary for learning progress and is defined as the *learning synchronicity*.

Finally, the outcome of the learning is indicated by the perceived learning performance. Summarizing the above explanations, Figure 1. shows the research model.

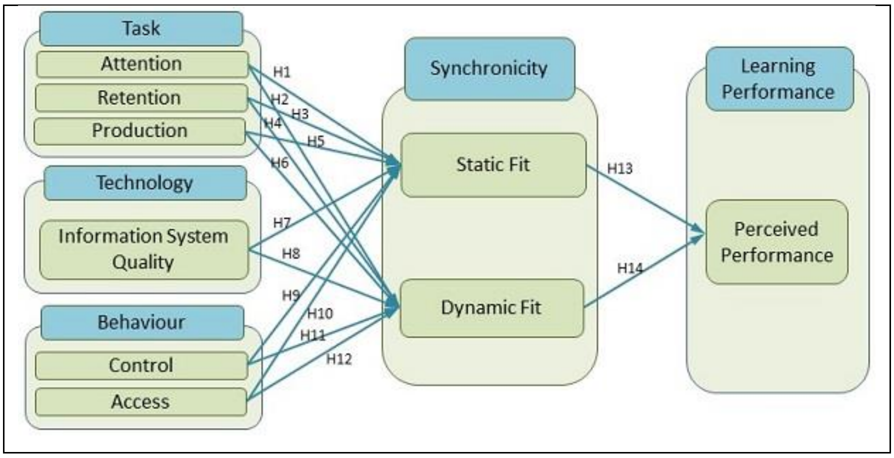

Figure 1. Research Model

Hypothesis Development

<u>Task on Synchronization</u>: Learning is a progressive process where students pay attention to the learning material, retain the learning, and then use (reproduce) the learning for practical applications (Jin et al., 2015). In an online learning environment, the learning information and the system are available for students use. In addition, students are able to use the system to communicate with the instructor and peers. Students must use the system for learning to progress in learning. Therefore, the *availability* and the *use* are distinct factors in learning. When the system and the information are available anytime and accessible from anywhere, students are able to use the system better during the three steps in learning. When the student progress in learning, the progress indicates that the information/system suits the learning need as well as the progress towards the learning goal. Such progressive activity indicates that the students retain the (prior) learning. When students complete the learning task by using the learning, the completion indicates the reproduction of the learning. Accordingly, the propositions,

H1. Attention is positively related to static fit in learning
H2. Attention positively related to dynamic fit in learning
H3. Retention positively related to static fit in learning
H4. Retention positively related to dynamic fit in learning
H5. Reproduction positively related to static fit in learning
H6. Reproduction positively related to dynamic fit in learning

Technology on Synchronization: Technology refers to the information and the system. Learning information available through the technology is in digital forms, e.g., text, audio, video, and/or graphics. The abstract/granularity levels of the information vary from one information type to another. The information must be available and reliable, in the proper form, proper granularity (suitable to the learning level), and timely. In addition, the LMS and the SNA must be able to provide functionalities necessary for learning for the above explained information needs. Accordingly, the propositions,

H7. Information/ System quality is positively related to static fit in learning
H8. Information/ System quality is positively related to dynamic fit in learning

Behavior on Synchronization: Behavior refers to the control and the access to learning. Students access the learning system independent of geographical constraints. Flexibility in access allows students to control their learning such as the location, time, and pace of learning. Even though students are provided with the formal LMS, students do use informal learning environments created by themselves through the SNA. Such informal systems provide students with greater control of the learning environment as they can control the network participants and the information. Therefore, the control and access to the learning system are important in contemporary learning environments. Accordingly, following propositions,

H9. Control is positively related to static fit in learning
H10. Control is positively related to dynamic fit in learning
H11. Access is positively related to static fit in learning
H12. Access is positively related to dynamic fit in learning

Synchronicity on Learning performance: When technology supports completion of the task, task performance can be achieved (Goodhue & Thompson, 1995; Kim & Ammeter, 2014). Facilitating the information availability and supporting the progressive learning encourages students to use the system for learning. Students start using the system at the beginning of the learning period and continue to use the system until the learning objectives are achieved. Continuous use of the learning system indicates the usefulness of the system. During the learning period, students pay attention to the learning material, retain the information and use the information to develop their knowledge (Halawi, McCarthy, & Pires, 2009; Jin et al., 2015; Yi & Davis, 2003). This learning process continues until the end of the learning period where students are able to achieve their learning objective. For students to achieve better progressive learning, technology must be aligned with the learning objectives as well as fitting the needs of the learning task (Goodhue & Thompson, 1995; Kim & Ammeter, 2014; Wang, Gray, & Meister, 2014). Accordingly, the synchronicity of the task, technology, and student behavior helps the learning performance. Thus,

H13. Static fit is positively related to perceived performance
H14. Dynamic fit is positively related to perceived performance

Data collection

Data collection occurred via an online survey. Since the research focuses on learning, the sample was a cohort of the student population. Participants were asked to indicate the extent of their agreement to the online survey questions by using 7-point Likert scale. Two surveys were used to capture data for formal learning experience and informal learning experience. Questions were randomized to maximize the use of the data and were analyzed by using SPSS and SmartPLS software.

Survey questionnaire included minimum of 3 questions to measure each variable. Attention, retention, and reproduction were measured by asking participants agreement of the extent of the attention, retention, and reproduction enabled by the learning system. Presenting the complete list of questions is out of scope for this paper due to the page limitation but more details will be available at the conference.

Results and Analysis

Once the data collection had been completed, data was checked for visible errors, missing values, and outliers. Responses with more than 10% missing values were removed from analysis (Flatten, Engelen, Zahra, & Brettel, 2011). Remaining missing values (which are less than 4%) were treated with mean value replacement for the analysis. In total, 118 usable responses were collected with 61 being for formal learning and 57 for informal learning. Analysis was conducted for formal and informal learning.

Measurement Model (Formal/Informal Learning)

The constructs were measured using reflective items. Formal and informal systems were analysed separately. The results from the measurement model showed very high factor loadings for each item to the relevant construct. For the formal learning system, the lowest value was 0.83 for the Retention construct while the lowest loading observed in informal learning system was 0.79 for the Static fit construct. Therefore, factor loadings are noted as very good and further analysis conducted to assess the structural model as shown below.

An examination of the quality criteria (formal and informal systems) was undertaken. AVE, composite reliability, R square, and Cronbach Alpha were examined (see Table1). All values received for AVE are above 0.70 for both formal and informal systems (Yi & Davis, 2003). As stated earlier the minimum loading received was 0.79. The lowest Cronbach alpha was 0.8655 indicating high reliability for the model constructs.

Table 1. Quality Criteria – Formal Learning (F) and Informal Learning (I)

	AVE	Composite Reliability	R Square	Cronbach Alpha
Access	F 0.8157 I 0.8713	0.9299 0.9531	0 0	0.8867 0.9261
Attention	F 0.8247 I 0.8695	0.9495 0.9638	0 0	0.9293 0.9493
Control	F 0.8332 I 0.8896	0.9523 0.9699	0 0	0.9329 0.9587
Dynamic fit	F 0.7913 I 0.8182	0.9381 0.9473	0.7189 0.6502	0.9129 0.9260
IS Quality	F 0.8363 I 0.8118	0.9623 0.9556	0 0	0.9509 0.9418
Performance	F 0.8349 I 0.9008	0.9529 0.9732	0.6648 0.6215	0.9340 0.9633
Reproduction	F 0.8818 I 0.9115	0.9572 0.9686	0 0	0.9330 0.9515
Retention	F 0.7899 I 0.8080	0.9184 0.9265	0 0	0.8655 0.8802
Static fit	F 0.8246 I 0.7894	0.9494 0.9372	0.6994 0.7203	0.9287 0.9094

Structural Model (Formal/Informal Learning)

The structural model analysis shows contrasting results for formal and informal learning. Figure 2 and Figure 3 below show the loadings and significance levels (from bootstrapping) for both systems. Percentage variance explained by explanatory variables (R^2) were 70% for Static Fit, 72% for Dynamic fit, and 67% for Perceived performance.

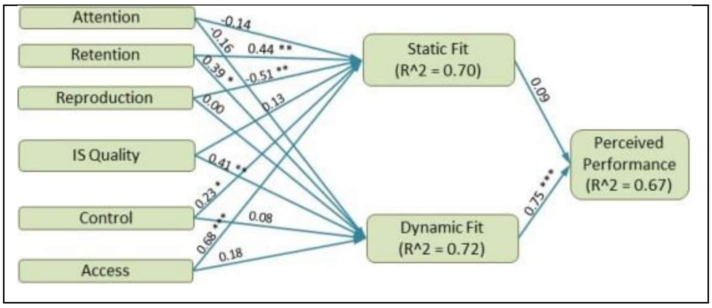

Figure 2. Formal System enabled Learning

* p<0.1, ** p<.05 and *** p<0.01at 0.05

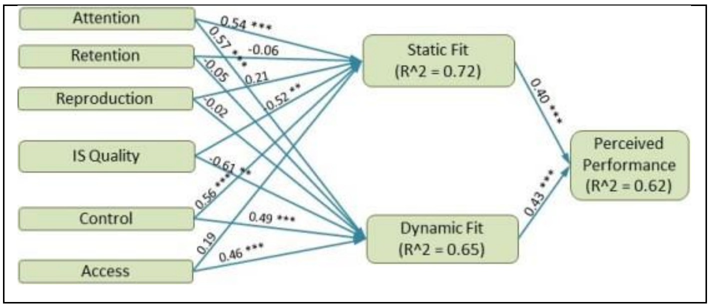

Figure 3. Informal System enabled Learning

* p<0.1, ** p<.05 and *** p<0.01at 0.05

For formal learning (Figure 2) retention, reproduction, control, and access are significant factors for static fit. Similarly, retention and IS quality are significant factors for dynamic fit. Dynamic fit is a significant factor for perceived performance. For informal learning (Figure 3) attention, IS quality, and control are significant factors for static fit. Similarly, attention, IS quality, control, and access are significant factors for dynamic fit. Both static and dynamic fit are significant factors for performance. Static fit is significant factor for performance in informal learning but, there is no conclusive evidence from the formal learning system from static fit to learning performance.

Discussion

We found distinct differences in formal and informal online learning systems. Both systems show they are highly relevant for perceived learning performance. In formal learning systems perceived performance was driven by dynamic fit, while both dynamic and static fit were significant drivers of perceived learning performance in informal systems. Attention is a strong driver of both dynamic and static fit in informal systems, but has little effect in formal systems. Retention and Reproduction are drivers of static fit in formal systems, but have little impact in informal systems. IS quality is a negative driver of both static and dynamic fit in informal systems, but it is a good driver for dynamic fit in formal systems. Control is a strong driver of both static and dynamic fit in informal systems, but has no influence in dynamic fit in formal systems. Access is a strong driver of static fit in formal systems and a strong driver of dynamic fit in informal systems. The differences in formal and informal systems cannot be explained with the current data. However, our pragmatic observations indicate that the students are highly connected to informal systems than to formal systems. Explanations of these differences need to be sought, and are the subject of further post hoc testing.

Conclusion

The task, technology, and behavioral characteristics in formal and informal learning show distinct differences in learning. Clearly synchronicity has a strong influence on perceived performance, but the drivers of synchronicity need to be better understood and the nature of contemporary learning in different systems needs to be taken into account in the design of both formal and informal learning systems. Increasing external validity can be achieved by collecting data from a larger and more representative sample.

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