Advancing a theoretical model for knowledge construction in e-learning

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Abstract

An active learning model was used as the theoretical model for knowledge construction. The model is comprised of three components. Underpinning and ownership components were treated as independent variables. The engaging component was treated as a dependent variable. The purpose of this study is to empirically examine whether there is a positive and significant relationship between the independent variables of underpinning and ownership and the dependent variable of engaging where knowledge construction takes place. Two hypotheses were formed. Data were collected and analyzed using SmartPLS, a variance-based structural equation modeling (SEM) package. Results were in favor of accepting the two hypotheses for the theoretical model. Findings, recommendations, and implications for further research are discussed.

Keywords: active learning, knowledge construction, theoretical model, SmartPLS, structural equation modeling

Introduction

E-learning, also known as *online education* or *online learning*, has become prevalent within higher education systems in the USA and the demand for online course offerings are increasing at an unprecedented rate. Allen and Seaman (2014) reported the following on the state of e-learning:

- 7.1 million higher education students are taking at least one online course.
- The 6.1 % growth rate represents over 400,000 additional students taking at least one online course.
- The percent of academic leaders rating the learning outcomes in online education as the same or superior to those as in face-to-face instruction grew from 57% in 2003 to 74% in 2013.
- The number of students taking at least one online course continued to grow at a rate far in excess of overall enrollments, but the rate was the lowest in a decade.

There is a strong consensus in the literature about securing "learning" in e-learning. Most scholars agree that constructivism is a preferred method of instruction in e-learning (Du Plessis & Koohang, 2007; Hung, 2001; Hung & Nichani, 2001; Koohang, 2009; 2012; Koohang & Harman, 2005).

Koohang (2012) stated that constructivism is about active learning. Through active learning, new knowledge is constructed. Constructivism theory is ingrained in the original research by Dewey (1933/1998), Piaget (1972), Vygotsky (1978), Ausubel (1968), and Bruner (1990).

The primary purpose of this paper is to advance a theoretical model for knowledge construction in e-learning based on an active learning model with three stages: underpinning, ownership, and engaging (Koohang 2012; & Koohang & Paliszkiewicz, 2013). The theoretical model is then empirically examined to find out whether there is a positive and significant relationship between the dependent variable of engaging and each of the two independent variables of underpinning and ownership. This study is consistent with its purpose and organized as follows:

A brief review of literature on e-learning, knowledge construction, and active learning is presented. Next, a theoretical model is advanced based on an active learning model with three constructs. The paper will then state the research hypotheses and study's methodology to empirically examine the relationship between the constructs. Subsequently, the results of the study are presented. The paper concludes with a discussion of the results and recommendations for future research.

Knowledge Construction

Davenport and Prusak (2000) suggested that knowledge transfer involves two actions: transmission and absorption. Knowledge transfer is the starting point of the knowledge building process. When knowledge absorption takes place the knowledge building process begins. Knowledge recipients then need to apply the new knowledge to real-world problems.

According to Bereiter and Scardamalia (2003), knowledge building is a process of creating new cognitive artifacts through interactive questioning, dialog and continuous self-transcending. Lukas et al. (2014) stated that complex thinking and higher phases of knowledge construction are achievable with appropriate design of activities. Wang et al. (2009) discussed the importance of choosing and determining topics that may influence the depth and levels of knowledge construction in online courses.

De Wever, Van Keer, Schellens, and Valcke (2009) found that assigning specific roles to students participating in asynchronous discussions leads to complex thinking. Lucas and Moreira (2010) stated that giving ownership of responsibilities to the students creates a complex thinking as the responsibility for the learning process is transferred to students and combined with autonomous learning, context situated problem based learning and intra and inter-group collaborative work.

In constructing knowledge, critical thinking and logical reasoning are essential objectives. Learners must learn to clearly explain their informed opinions and give reasons for the way in which they carry out tasks and solve problems (Ravenscroft & McAlister, 2008; Ravenscroft, Wegerif, & Hartley, 2007).

In constructing knowledge, Nonaka and Takeuchi (1995) focused on the dynamics of knowledge activities. The authors noted that 1) socialization, 2) externalization, 3) combination and 4) internalization are the main activities in knowledge construction.

Koohang (2012) asserted that constructivism

> "...insists on reinforcing higher-order thinking skills, exploration, and scaffolding based on raw data and real-world problems. It requires learners to actively and continuously participate in ownership of their learning. Active learning gives learners the opportunity to create knowledge in the course of social negotiation." (p. 75)

Based on their earlier work, Koohang and Paliszkiewicz (2013) developed an active learning model. They identified and validated specific learning activities in each of the stages (Table 1). Such activities appear to be relevant and critical in the construction of knowledge in e-learning courses. This study further explores the relationship among the three stages in an effort to understand the idea of active learning.

The Theoretical Model

Koohang (2012) advanced an active learning model stating that knowledge construction is achieved through three main stages. The stages are: underpinning, ownership, and engaging. The model asserts that all stages with their elements must be present in the design of active learning in e-learning. These elements complement each other for knowledge construction. The elements with the roles and responsibilities of both the learners' and the instructor's for each stage are as follows:

Active Learning: ***Underpinning Elements***	***Learner*** ***(Role and Responsibilities)***	***Instructor*** ***(Role and Responsibilities)***
• Real world and relevant examples • Exploration • Higher-order thinking skills (Analysis, evaluation, & synthesis) • Scaffolding that can be used to make learners think above and beyond what they normally know		• Designing into all course activities immediately to guide learners to become active learners and initiate deep learning

Source: Koohang (2012)

Active Learning: Ownership Elements	***Learner (Role and Responsibilities)***	***Instructor (Role and Responsibilities)***
• Learner's driven goals and objectives • Learner's self-mediating and control of learning • Learner's self-reflection & self-awareness • Learner's own experience • Learner's self-assessment • Learner's own representation of ideas and/or concepts	• Setting own goals & objectives • Taking control of learning • Reflecting • Being aware of learning • Including own experiences • Self-assessing • Presenting ideas and/or concepts	• Designing into all course activities immediately to guide learners to become active learners by participating in the ownership of learning • Actively communicating

Source: Koohang (2012)

Active Learning: Engaging Elements	***Learner (Role and Responsibilities)***	***Instructor (Role and Responsibilities)***
• Learners' active engagement in analysis, evaluation, & synthesis of multiple perspectives • Learners' collaborative assessment	• Actively creating knowledge	• Actively coaching, guiding, mentoring, tutoring, & facilitating • Actively providing feedback • Actively assessing • Actively communicating

Source: Koohang (2012)

The process of constructing knowledge begins with the instructor designing the elements of the underpinning stage into activities and assignments. Next, the ownership elements are designed into activities and assignments to guide learners to actively involve themselves in the ownership of learning. The final stage, engaging, relies completely on the underpinning and ownership stages for knowledge construction. It is in the engaging stage that learners actively and collaboratively construct new knowledge (Koohang 2012).

The present paper seeks to empirically examine whether there is a positive and significant relationship between the engaging stage (where knowledge construction is accomplished) and each of the two stages of underpinning and ownership. As a result, the following model is proposed to be examined (See Figure 1).

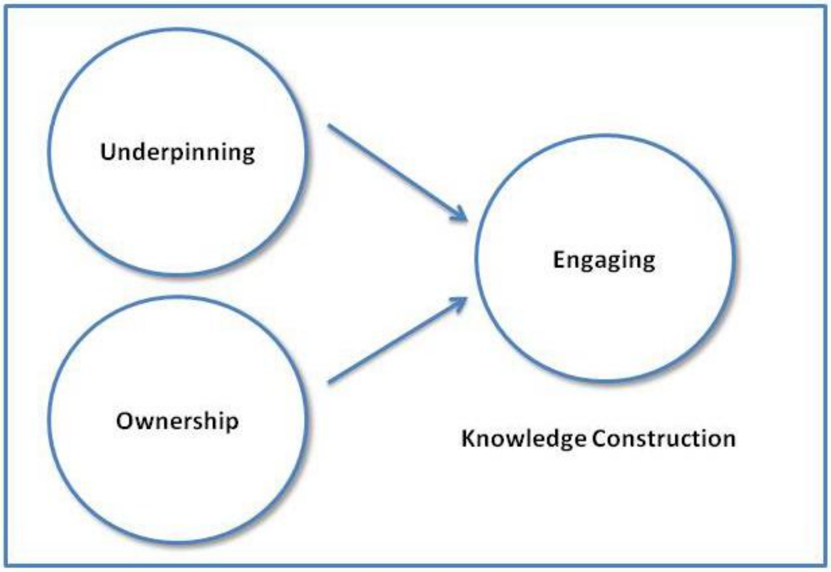

Figure 1: The Proposed Research Model of Underpinning and Ownership on Learners' Engaging in Knowledge Construction

The items for the constructs are as follows:

Underpinning - Independent Variable
U1: Real world and relevant examples
U2: Exploration
U3: Higher-order thinking skills (Analysis, evaluation, & synthesis)
U4: Scaffolding

Ownership - Independent Variable
O1: Learner's driven goals and objectives
O2: Learner's self-mediating and control of learning
O3: Learner's self-reflection & self-awareness
O4: Learner's own experience
O5: Learner's self-assessment
O6: Learner's own representation of ideas and/or concepts

Engaging - Dependent Variable
E1: Learners' active engagement in analysis, evaluation, & synthesis of multiple perspectives
E2: Learners' collaborative assessment

Based on the above model, the following research hypotheses are stated:

> H1: The *underpinning* component of the active learning model is significantly and positively contributing to the *engaging* component.
> H2: The *ownership* component of the active learning model is significantly and positively contributing to the *engaging* component.

Methodology

Instrument

The instrument for this study was designed based on the Active Learning Model with three stages (underpinning, ownership, & engaging) advanced by Koohang (2012). The construct validity of this instrument was determined in a later study by Koohang and Paliszkiewicz (2013), which implied that the three constructs in the model were empirically validated to be reliable and interpretable among their associated factors.

The instrument consists of 12 items with a 5-point Likert-type scale: strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, and strongly disagree = 1. The instrument items were stated as follows:

Underpinning

1. Inclusion of higher-order thinking skills (analysis, evaluation, & synthesis) in online activities, assignments, and/or projects is important to my learning.
2. Through exploration in online course activities, assignments, and/or projects, I can seek knowledge independently and manage my learning goals.
3. Learning becomes more meaningful if real world and relevant examples are used in the online activities, assignments, and/or projects.
4. The online activities, assignments, and/or projects should encourage me to think above and beyond what I normally learn.

Ownership

5. I learn better if I am asked, through online activities, assignments, and/or projects, to set my own learning goals and objectives.
6. I learn better if I am involved, through online activities, assignments, and/or projects, in self-mediating and control of my learning.
7. Encouraging self-awareness, self-analysis, and self-reflection in online activities, assignments, and/or projects are very important to my learning.
8. Online activities, assignments, and/or projects should encourage me to include my own previous experience in solving a problem.

9. Online activities, assignments, and/or projects should encourage me to do self-assessment about my learning.
10. Online activities, assignments, and/or projects should encourage me to present my own ideas/concepts.

Engaging

11. Online activities, assignments, and/or projects should encourage active analysis, evaluation, & synthesis of multiple perspectives expressed by everyone.
12. Online activities, assignments, and/or projects should encourage everyone to assess each other's learning progress. (Koohang & Paliszkiewicz, 2013, p 111 - 112)

Procedure

The survey instrument was approved by the institution's Institutional Research Board (IRB) and administered to 118 students from a higher education institution in the Southeast, USA. The participants were enrolled and actively participated in various information technology online courses. The participants were males and females with various age group ranging from 18 to over 40. The participants were taught by various instructors requiring active learning that included regular and routine course activities, assignments, and/or projects.

Data Analyses

Data were analyzed using the SmartPLS 2.0, a structural equation modeling (SEM) package. SmartPLS is a variance-based SEM that is preferred over a covariance-based SEM such as IBM's AMOS or LISREL because it is less sensitive to sample size smaller than 300 records (Chin, 1998; Henseler, Ringle, & Sinkovics, 2009). The following analyses were conducted:

1) *Convergent Validity:* According to Fornell and Larcker (1981), convergent validity can generally be achieved by meeting the following three criteria:

1. Criterion 1: all item factor loadings should be significant and greater than 0.70
2. Criterion 2: The average variance extracted (AVE) for each construct should be greater than 0.50. AVE is the amount of variance captured by a latent variable (LV) relative to the amount caused by measurement error.
3. Criterion 3: the composite reliability index for each construct should be greater than 0.80.

The above criteria constitute achievement of a satisfactory level of convergent validity. If items fall below 0.70, the loadings in the construct would be acceptable given that the loadings of other items for the same construct are high (Chin, 1998), and the loading is still higher than the cutoff point of 0.4 (Straub, Boudreau, & Gefen, 2004).

2) *Discriminant Validity*: Discriminant validity is verified by the difference between the AVE of a construct and its correlations with other constructs. The sufficient discriminant validity is achieved if the square root of AVE of a construct is greater than its correlations with all other constructs (Fornell & Larcker, 1981).

3) *Structural Model:* The hypotheses are assessed by examining the parameters provided by the PLS structural model. First, the R^2 value of the dependent variable indicates the predictiveness of the theoretical model. To make any meaningful interpretation the minimum 10% criterion should be achieved (Falk & Miller, 1992). Secondly, the standardized path coefficients represent the strength of the contribution of the independent on the dependent variable (Chin, 1998).

Results

Before proceeding with the analyses, outlier analysis was conducted to eliminate cases containing extreme multivariate outliers that may have skewed the results. Following multivariate outliers, two cases were identified and removed from further analyses. This yielded a final sample population of 116 subjects for the analyses.

Convergent Discriminant Validity

The average variance extracted (AVE) for each construct were greater than 0.50. The composite reliability index for each construct was greater than 0.80 (See Table 1). The discriminant validity was verified by the difference between the AVE of a construct and its correlations with other constructs. The square root of AVE of each construct was greater than its correlations with all other constructs (AVE = 0.799631, Square Root = 0.894220; AVE = 0.554216, Square Root = 0.744456; AVE = 0.673727, Square Root = 0.820808), therefore; the sufficient discriminant validity was achieved (See Table 1). Furthermore, All item factor loadings were significant and greater than 0.70. (See Table 2)

Table 1: Test of Reliability, Convergence Validity, and Discriminant Validity

	AVE	CR	Engaging	Ownership	Underpinning
Engaging	0.799631	0.888530	1.000000		
Ownership	0.554216	0.881722	0.666277	1.000000	
Underpinning	0.673727	0.891924	0.733975	0.669029	1.000000

Table 2: Factor Loadings

	Underpinning	Ownership	Engaging	P-Value
U1	0.824857			< .001
U2	0.805678			< .001
U3	0.857109			< .001
U4	0.794208			< .001
O1		0.750813		< .001
O2		0.705064		< .001
O3		0.742929		< .001
O4		0.766430		< .001
O5		0.751045		< .001
O6		0.749022		< .001
E1			0.861138	< .001
E2			0.926123	< .001

Structural Model

The hypotheses were assessed by examining the PLS results. The R^2 value of the model on the dependent variable was 0.59 indicating significant predictiveness of the model. The R^2 value exceeded significantly the minimum 10% criterion for any meaningful interpretation of the results. The standardized path coefficients that represent the strength of the contribution of the independent variables (*underpinning* & *ownership*) on the dependent variable (*engaging*) were $\beta_{H1} = 0.317209$ & $\beta_{H2} = 0.521752$ respectively, with both demonstrating significance of $p < .001$. These results suggest that the theoretical model demonstrated substantive explanatory power.

Hypothesis 1 that stated the *underpinning* component of the active learning model is significantly and positively contributing to the *engaging* component was supported, T statistics= 3.416090 and p = < .001.

Likewise hypothesis 2 that stated the *ownership* component of the active learning model is significantly and positively contributing to the *engaging* component was supported, T statistics = 5.637536, and p = < .001 (See Table 3).

Table 3: Results of t-Statistics for Hypotheses

Structural Paths in the Model	PLS Path Coefficient	T Statistics	P-Value
H1: Underpinning -> Engaging	$\beta = 0.317209$	3.416090	< .001
H2: Ownership -> Engaging	$\beta = 0.521752$	5.637536	< .001

Conclusions and Discussion

This study proposed a theoretical model for knowledge construction based on an active learning model that consisted of three stages: underpinning, ownership, and engaging. The model asserts that the construction of knowledge starts with designing elements of the underpinning stage into activities and assignments. Next, the ownership elements are designed into activities and assignments to guide learners to become actively involved in the ownership of learning. The engaging stage entirely depends upon the underpinning and ownership stages for knowledge construction. It is in the engaging stage that learners actively and collaboratively construct new knowledge based on what has been accomplished in the underpinning and ownership stages (Koohang 2012; Koohang & Paliszkiewicz, 2013). The theoretical model sought to empirically examine: 1) whether there is a positive and significant relationship between the underpinning stage and the engaging stage; and 2) whether there is a positive and significant relationship between the ownership stage and the engaging stage. The instrument used in this study was validated by Koohang & Paliszkiewicz (2013) and implied that the three components in the model were empirically validated to be reliable and interpretable among their associated factors.

Collected data were analyzed using the SmartPLS 2.0. Analyses revealed a high indication of predictability of the theoretical model. Furthermore, the results of the standardized path coefficients represented acceptable values indicating the strength of the relationship between the dependent variable of engaging and the two independent variables of underpinning and ownership. Convergence validity and discriminant validity were achieved as indicated by all satisfactory factor loadings, acceptable AVEs and composite reliabilities.

The hypothesis that stated the underpinning component of the active learning model is significantly and positively contributing to the engaging component was supported. Likewise hypothesis that stated that the ownership component of the active learning model is significantly and positively contributing to the engaging component was supported.

Effective e-learning instruction that is learner-centered and leads into knowledge construction depends on how well the elements of active learning are designed into course activities, assignments, and/or projects. The findings of this study indicated that the elements of underpinning (i.e., real world and relevant examples; exploration; higher-order thinking skills; and scaffolding) and the elements of ownership (i.e., learner’s driven goals and objectives; self-mediating and control of learning; self-reflection & self-awareness; own experience; self-assessment; their own representation of ideas and/or concepts) are clearly *linked to the elements of engaging (i.e.,* learners' active engagement in analysis, evaluation, & synthesis of multiple perspectives; and learners' collaborative assessment).

Within the proposed model, the underpinning and ownership stages are positively and significantly contributing to the engaging stage. This implies that the underpinning and ownership stages prepare learners to enter the engaging stage, as the final stage, to achieve the construction of new knowledge.

The proposed model for knowledge construction in e-learning is systemic. The construction of knowledge can best be accomplished if all elements of the three stages are present and included in the design of online course activities, assignments, and/or projects.

In a true knowledge construction setting, the role of the instructor is significant and must not be overlooked. It is the instructor that facilitates the course. It is the instructor that encourages and facilitates ownership of the learning among learners. Furthermore, it is the instructor that actively coaches, guides, mentors, and tutors the learners. Finally, the instructor provides feedback, assesses students' learning, and actively communicates with the learners.

In summary, instructors should not only be actively engaged throughout the delivery of the course, but should be very intentional in making sure that the three stages (underpinning, ownership, and engaging) with their associated elements are included in online activities, assignments, and/or projects for attaining knowledge construction in e-learning. This study highlights further validation of the knowledge construction as presented in the Active Learning model proposed by Koohang (2012).

Study Limitation and Recommendations

The study limitations include a moderate sample size of 116. Furthermore, the study used a sample of convenience from one higher education institution. Future studies may include a wider sample size from diverse higher education intuitions with an attempt to validate the Active Learning model on larger group of participants. A future direction may expand the Active Learning model by testing its validity in diverse programs such as engineering and allied health-care where internship as well as apprenticeship may be a critical part of the knowledge construction process. Moreover, given the increased use of e-learning systems for professional corporate training, additional research should attempt to validate the model in the context of e-learning based corporate training as well.

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Biographies

Alex Koohang has spent more than twenty five years in the academic community. Dr. Koohang has served as Assistant Professor, Associate Professor, Full Professor, Program Coordinator, Program Director, Division Head, and Dean. He has published and presented numerous papers. His scholarly activities also include serving as the editor-in-chief of JCIS and serving on the editorial review board of several IS publications. Dr. Koohang is active in IS/IT curriculum design and has recently helped design a world-class IT program for Middle Georgia State College's School of IT leading it to ABET accreditation. He is the Peyton Anderson Eminent Scholar and Endowed Chair in Information Technology. He was named the 2009 Computer Educator of the Year by IACIS.

Joanna Paliszkiewicz is a specialist in management issues connected with knowledge management, intellectual capital and trust management. She holds the rank of University Professor of Warsaw University of Life Sciences and Polish-Japanese Institute of Computer Technologies. Prof. J. Paliszkiewicz is well recognized in Poland and abroad with her expertise in management issues. She has published over 122 original papers and 3 books. She serves on the editorial board for several international journals. She is the deputy editor-in-chief of Management and Production Engineering Review Journal. Prof. J. Paliszkiewicz has been awarded a number of grants sponsored by Polish Ministry of Sciences. In recognition in her outstanding teaching and research, Professor J. Paliszkiewicz has been the recipient of the two awards of excellence from the Rector of the Warsaw University of Life Sciences. Dr. Paliszkiewicz was named the 2013 Computer Educator of the Year by IACIS.

Jeretta Horn Nord is Professor of Management Information Systems at Oklahoma State University. She has recently served as Visiting Scholar at the University of California at Los Angeles and as a Visiting Professor at the University of Southern Queensland in Australia; she has also been named Computer Educator of the Year by IACIS. Dr. Nord has authored numerous articles, proceedings, conference papers, and books in the areas of e-business, corporate knowledge requirements and entrepreneurship. Jeretta has presented papers in over 20 countries and serves as Director of Publications to the IACIS Executive Board and Executive Editor of The Journal of Computer Information Systems. She holds the Jeanine Rhea/Oklahoma International Women's Forum Professorship and was recently named among the top 20 women professors in Oklahoma.

Michelle M. Ramim is a part-time professor at the School of Information Technology at Middle Georgia State College as well as Huizenga School of Business and Entrepreneurship at Nova Southeastern University. She has extensive experience in information technology (IT) consulting. Dr. Ramim directed the development and implementations of several IT projects including promotional and interactive websites for major enterprises such as Debeer (Diamond Trading Company). Her current research interests include ethical issues with IT, information security and crisis management, legal aspects of computing, as well as ethical decision making. She has published articles in peer-reviewed outlets including journals, conference proceedings, encyclopedias, and an invited chapter. Moreover, she has been serving as a referee research reviewer for national and international scientific journals, conference proceedings, as well as MIS textbooks. She has developed the supplemental material for the Pearlson and Saunders (2012) 5th ed book "Managing and Using Information Systems: A Strategic Approach" by Wiley & Sons. She earned her Bachelor's degree from Barry University in Miami Florida. Dr. Ramim has received her Executive MBA from Florida International University. She completed her Ph.D. in Information Systems at the Graduate School of Computer and Information Sciences, Nova Southeastern University.