Does IT Promote Collaborative Processes and Improve Learning? An Activity Theory Approach

Completed Research

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Abstract

Computer-supported collaborative learning (CSCL) is rapidly emerging as an interdisciplinary field that is focused on how technology can facilitate group learning. Much research has been conducted into CSCL's contribution to learning and the roles of various factors leading to its effectiveness. An area that has escaped focus is investigation into the nature of collaborative processes and the features of technology platforms that may support them. We use an Activity Theory framework to model the relationship between platform features, group processes, and the learning outcome. The results of this empirical study demonstrate that there are features of the technology platform that promote key elements of the collaboration process, thus promoting better learning outcomes and acceptance. We use the Technology Acceptance Model to study the acceptance of the platform. The study can help guide the design of technology platforms that are conducive to productive group activities and collaborative learning.

Keywords

Activity theory, Collaborative learning, Group processes

Introduction

With its roots in cognitive, social, and psychological areas, collaborative learning has become a dominant paradigm in higher education (Davidson et al. 2014, Barkley et al. 2014). Social media and Web 2.0 tools have come to play a critical role in making collaborative learning practical and efficacious (Resta and Laferriere 2007). Computer-supported collaborative learning (CSCL) is now a growing area in the field of learning technologies. While it is part of the larger study of how technology promotes learning (Gribbins et al. 2007), the focus of CSCL research is on establishing the efficacy of the approach and the role played by supporting factors such as computer-led evaluation and document repository (Resta and Laferriere 2007, Popescu 2014). In the field of CSCL research, one area that has escaped attention is group processes among students and the facilitating role of a technology platform as opposed to individual discrete technologies. It has been observed that there is a substantial body of knowledge on collaborative learning in face-to-face settings, but less is known about CSCL (Jeong et al. 2014), particularly the collaborative aspects. "Despite numerous studies on social interactions in collaborative learning, little is known about interactions in successful computer-supported collaborative learning situations," write Vuopala et al. (2016). Similarly, in the design of online environments, much attention has been paid to interface design, but much less to designing forums where students can interact, according to McLoughlin and Marshall (2000). Strijbos et al. (2004) note that "more research is needed on the design element of CSCL software to determine the extent to which they support, structure,... the interaction." According to Popescu (2014), the impact of integrated social learning environments based on Web 2.0 tools (wikis, social media, blogging, etc.) has not received its due attention "with little recognition of the other factors that make it effective" (Smith and McKeen 2011).

In this paper, we use the Activity Theory (AT) framework (Reference required). In the simple version of AT, the basic elements are a *subject* that is engaged in manipulating an *object* using a *tool,* which results in an *outcome* (Figure 1). The tools we focus on here are capabilities of the IT platform, such as exchanging ideas and mutual editing; the object here is the group process relating to coordination and cohesion, and the resultant outcome is academic efficacy. The Technology Acceptance Model (TAM) (Reference required) is used to model acceptance of the collaborative learning approach. By identifying the nature of the IT platform in terms of the above capabilities and the nature of group processes in terms of their goals, and measuring the impact of the former on the latter, this paper can provide valuable guidance to platform developers for the CSCL environment. It is one of the few papers that focuses on interaction between technology features and group processes in the context of CSCL.

Research Background

According to Romiszowski (2004), in the field of educational technology, new communication and computing technologies are welcomed as major innovations in learning, but the technology often fails to live up to its promise. This has been true for TV, radio, the VCR, and most recently ebooks. "*History is littered with failed attempts to 'revolutionize' learning through innovative technology. Fortunately, these struggles have taught us one very important lesson: in order for technology to improve learning, it must 'fit' into students' lives…not the other way around*" (Clarke, 2002). Greenagel (2002) cautions that learning happens in a community that has both relational and cognitive elements. According to Pawan et al. (2003), "collaborative interactions are an essential element of any pedagogy which assumes that good learning is collaborative and that understanding comes through modeling, participation in, and reaction to the behaviors and thoughts of others."

The rise of computer-supported collaborative learning (CSCL) in higher education as a new paradigm is a result of many trends coming together: "the development of new tools to support collaboration, the emergence of constructivist-based approaches to teaching and learning, and the need to create more powerful and engaging learning environments" (Resta and Laferriere 2007). There are no universally adopted meanings for the term "collaborative learning" and its sister concept "cooperative learning," or agreement on the precise differences or commonalities between the two concepts. According to Barkley, Major, and Cross (2014), collaborative learning (CL) is an umbrella term that stands for group learning, and its essence is students working together to create new understanding. Instances of collaborative learning share some features. Co-laboring is crucial to collaborative learning. Students engage in interpersonal and small-group activities to develop a solution. The task assigned helps the teams to accomplish the learning outcome of the course. Students assume authority and control over their learning process so that they develop into autonomous, articulate, and thinking individuals. Students bring to their group different backgrounds and skill levels, and a synergy happens that results in a final product that is greater than the sum of individual student contributions, which is the creative aspect of their learning outcome. Panitz (1996) views collaboration as a philosophy of interaction and personal lifestyle, while cooperation is viewed as a structure of interaction designed to facilitate accomplishment of an end product or goal through people working together in groups. Slavin (1997) associates cooperative learning with well-structured knowledge domains, and collaborative learning with ill-structured knowledge domains.

Three theories to date have dominated the study of education: (1) behaviorism: learning as the acquisition of stimulus-response pairs, (2) cognitivism: learning as the processing of information and models, (3) constructivism: learning as the construction of knowledge in a social setting (Reference required). The foundational issue is the role of epistemology—that is, what is the nature of knowledge and how does a knower come to acquire it? From this perspective, Doolittle and Hicks (2003) cited the epistemology underlying the CSCL literature as:

- Knowledge construction is an individually and socially active process.
- This is an adaptive process that seeks to make one's thoughts and behavior more effective in realizing one's goals.
- Understanding of one's experience is a function of individual and social interpretation of one's experience.

In the history of research on collaborative learning, several researchers have moved towards a synthesis of two main traditions: Vygotsky's (1978) sociocultural approach called Activity Theory and neo-Piagetian ideas of socio-cognitive model (e.g., Doise 1985). The subject of CSCL has gone through several historical phases (Dillenbourg et al. 2009). Biggs (1989) suggested a typology for learning sciences in terms of three

Ps: product (quality of education), process (pedagogical approaches), and presage (the context) in which education takes place. Initially, as CSCL emerged from the subject of face-to-face collaborative learning, the focus was on the product and determining if CSCL was at all efficacious. This was the product phase. In the next phase, a community around the CSCL emerged and a wider perspective came to be adopted in terms of the whole life cycle of social interactions, that is, the process. Now, the presage factor has come into prominence, as challenges to successful implementations have emerged, with students and instructors often expressing frustration and failure (Capdeferro and Romero 2012). At the 2016 Conference on Learning Sciences, some of the challenges of CSCL were identified as how collaboration is to be measured and accounted for, what outcome measures should be used, what different affordances are made available by technology, and how to model technology enabling the individual (Ludvigsen 2016) to work in a group setting. The last question is the focus of our current research.

Research Questions

Our quest is to identify how information technology (IT) promotes collaborative processes and if that leads to learning and acceptance. We formulated the following research questions for that purpose:

1) Do performative and communicative features of an IT platform promote collaborative processes?
2) Do collaborative processes that relate to task coordination and group solidarity lead to higher perceived learning outcomes and creativity?
3) Do ease of use and higher perceived learning outcomes promote acceptance of a collaborative learning approach?

The rest of the paper is organized as follows: the next section sets out our theoretical framework, followed by the research model, data analysis, and finally the conclusion.

Theoretical Frameworks

We use Activity Theory and the Technology Acceptance Model (TAM) to frame our research. Figure 1 describes Activity Theory, and Figure 2 shows our research model based on these theories.

Activity Theory

Leontev (1978) and Vygotsky (1978) pioneered the development of Activity Theory (AT), in which all human activity is viewed as a social phenomenon where the individual is also socially situated. AT is a meta-theory or framework rather than a predictive theory. It considers an activity system where an individual subject is manipulating an object, which is the goal or the subject matter that the subject is engaged with, using a tool.

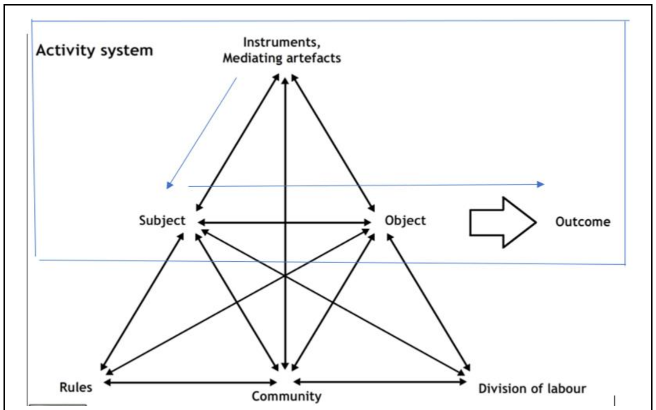

Figure 1: Activity Theory Framework

Engeström (1987) introduced the concept of the activity system model, which added more components—community, rules, and roles, as in Leontiev's (1978) "subject–object" interaction. As Engeström (1993) has noted, AT does not offer "ready-made techniques and procedures" for research; rather, its conceptual tools must be "concretized according to the specific nature of the object under scrutiny," which is what we do in our research.

In the field of information systems, AT became popular in human computer interface (HCI) studies, where researchers recognized quite early the importance of social context and human agency and motivation. Kaptelinin and Nardi (2006) and Nardi (1996) employed AT to claim that in designing computing technology, it is critically important to take into account that people act through technology, rather than interact with it.

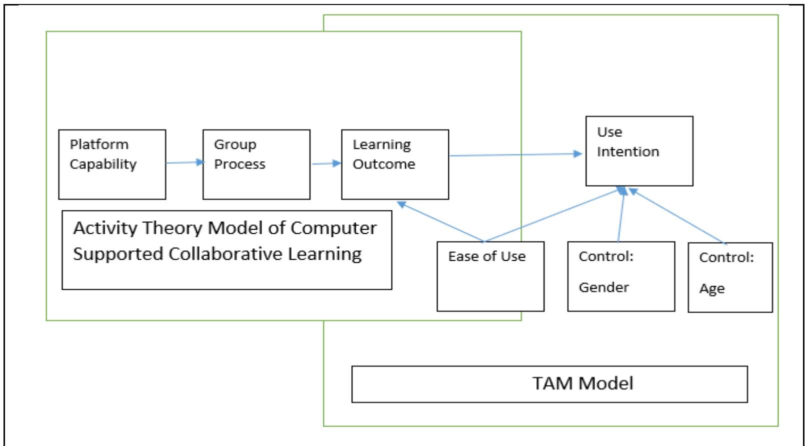

Figure 2: Basic Model of Research

Technology Acceptance Model

Davis (1989) was first to introduce the Technology Acceptance Model (TAM) (Figure 1), in which he assumes that users' adoption of computer systems depends on their behavioral intention to use them, which in turn depends on two variables: perceived ease of use and perceived usefulness. Davis (1989) advanced his thoughts based on the Theory of Reasoned Action (TRA), which was developed by Fishbein and Ajzen (1975). The model suggests that when users are presented with a new software package, a number of factors influence their decisions about how and when they will use it. Davis (1989) defined perceived usefulness (PU) as "the degree to which a person believes that using a particular system would enhance his or her job performance" and perceived ease of use (PEOU) as "the degree to which a person believes that using a particular system would be free from effort."

Research Model and Hypotheses

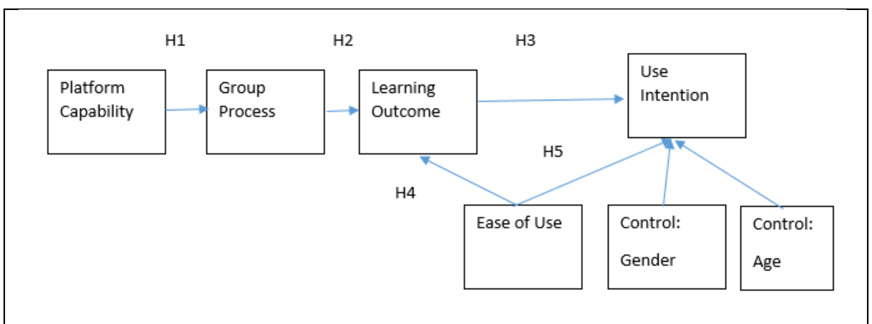

Figure 3: Research Model and Hypothesis

AT is much in use in the HCI world, where the user in a social context is much emphasized. The focus of such research is the use of IT tools in the context of a social world. Group Decision Support Systems (GDSS) also focus on the central theme of how IT promotes productive work, such as group decisions. The features identified in the HCI, IS, and GDSS worlds include friendly and interactive user interfaces, synchronous and asynchronous communication links, modeling, and decision support (Chen et al. 2018, Candea et al. 2016, Straub and Beauclair 1998) as groups negotiate a mutually agreed solution to "unstructured, nebulous and ill-defined problems" (Applegate et al. 1986) Underlying GDSS research is the basic theme of performative and communicative capability of IT promoting effective group work. Hence, we propose that:

H1: Learner perceived performance and communicative features of the IT platform will positively influence group processes related to task and group solidarity.

Doolan and Gilbert (2017) and Doolan (2013) found evidence from student reports that tools such as WhatsApp, StudyNet, and Google Drive helped students "to plan our meeting and plan our work" and also "increased productivity and friendship," and were used for "discussing ideas" and to go into the computer screen of another and do joint work. Similarly, Miyazoe and Anderson (2010) found strong evidence that using Web 2.0 tools, students were able to develop collaborative spaces where they could read, edit, and reflect on each other's work and which they found useful. Hence, we propose that:

H2: Learner perceived group process features of task and group solidarity will positively influence learning outcomes related to creativity and academic competence.

These hypotheses are from the TAM part of the model. TAM is usually employed in the acceptance of a new technology by an individual person, but AT tells us that using a technology is a social act that happens in the context of a group or society with its own rules and expectations. This approach was later reinforced by the social-constructive approach, where learning consists of creating new understanding in response to interaction within a society. Thus, an individual learning and accepting use of a new technology is engaging in some social activity that enables the individual to learn and accept the new tool. Zabukovsek et al. (2013) extended the use of TAM to situations where a large number of employees are interacting with an ERP platform. Amoako-Gyampah (2007) investigated the use of basic TAM constructs and hypotheses in ERP implementation. Likewise, we are using the TAM to study acceptance of a social activity, collaborative learning, that is mediated by technology. Hence, using the TAM hypotheses, we propose that:

H3: Learner perceived outcomes related to creativity and academic competence will positively influence willingness to use a computer-supported collaborative learning platform.

H4: Learner perceived ease of use of the platform will positively influence outcomes related to creativity and academic competence.

H5: Learner perceived ease of use of the platform will positively influence willingness to use a computer-supported collaborative platform.

Methodology

Research Method

We have chosen to test our theoretically derived research model with survey data collected from undergraduate students in business schools in New England and Midwest. The demographic characteristics are shown in Table 1. In our research and survey, the unit of analysis is the individual engaged in an activity in a group setting assisted by technology. In socio-cultural theories, the unit of analysis is groups of individuals participating in broad systems of practices (Lave and Wenger 1991). Socio-constructivist theories, on the other hand, focus on individual students and view learning as an act of participation in a society (Palincsar 1998).

Measures

Key definitions of our measures are:

IT Platform	The platform is measured in terms of its capability: performative and communication capability of a platform that is an aggregate of several Web 2.0 tools such as wikis, blogs, microblogging tools, social bookmarking tools, and media sharing tools (Popescu 2014, Kuo et al. 2014)
Group Process	The process is measured in terms of goals: group interactions relating to socio-emotional expressions such as expressing cohesion and coordination of group activities such as work and skills integration. (Vuopola et al. 2016, West 2002)
Learning Outcome	Outcome related to creativity and academic competence (Vuopola et al. 2016, Anders and Rolland 1994)

We developed instruments by adopting and adapting existing measures from previous research (see Table 6 for details).

Data Collection

Respondents	% respondents	Respondents	% respondents
Male	55	Freshman and Sophomore	51%
Female	45	Junior & Senior	49%
Age: below 20 years	31%	Age equal to or above 20 years	69%

Table 1: Sample Demographics

The unit of data collection in our research is a single student. Undergraduate students from two business schools in New England and Midwest were surveyed. Seven sections were involved, and they were all sections smaller than 30 students each. Over 150 responses were received, out of which about 25 were rejected. Student groups of 3-5 members worked on a design and analysis project that lasted several weeks. The projects allowed for many good solutions, and students had to decide on their own as to the depth and breadth of investigation needed in order to execute the project. Students within the same team often belonged to different majors, and the project allowed their inputs to be used. Teams were encouraged to choose team leaders and develop a team charter signed by the members that spelled out members' duties and responsibilities. The instructor took a "hands-off" approach, with groups occasionally meeting with him to get his verbal feedback. Students met face-to-face and also used WhatsApp, Skype, shared Google Drives, and Blackboard.

Results

Assessment of Measurement Model

Reflective Constructs: We tested for reliability and convergent and discriminant validity. Formative constructs are treated differently from reflective constructs. We assessed the reliability of reflective constructs with Cronbach's alpha coefficient, composite reliability, and significance of item loading (see Table 2). The reflective construct of top relational capital achieved a score above the recommended value of 0.7 for Cronbach's alpha (Nunally and Bernstein 1994) and composite reliability (Nunally and Bernstein 1994), "but values should not be lower than 0.6," and that is what we have achieved in this exploratory study (see Table 2). The cross loadings for non-formative constructs are shown in Table 4. The values ensure the scale reliability and the internal consistency of the construct in our research model.

For convergent validity of the reflective construct, we examined the factor loadings of the individual measure and the average variance extracted (AVE) (see Table 3). The AVE values for the reflective constructs were above the minimum recommended value of 0.50 (Fornell and Larcker 1981). For discriminant validity, we have Table 4, which shows that the AVEs for the reflective construct relational capital are much greater than their highest squared correlation with any other latent variable, thus ensuring discriminant validity.

Formative Constructs: The formative measurement model is assessed differently. The validity of formative constructs is assessed at two levels: the indicator level and the construct level. The indicator validity is assessed by indicator weights being significant at the 0.05 level (Chin 1998) and also by the variance inflation factors (VIF) being below 10 (Gujarati 2003). All items met these requirements of indicator significance and VIF values. Validity at the construct level in terms of inter-construct correlations is assessed by having the correlations be less than 0.7, which is the case (Table 4) (Henseler et al. 2009). At the construct level, nomological validity is ensured by having a relationship among formative constructs as justified in terms of prior literature, which is also the case here (Henseler et al. 2009).

Construct	CR	CA	AVE	Indicator	Loading(reflective)/weight(formative)	VIF
IT Platform (formative)	n/a	n/a	n/a	PT1	0.6	2.2
				PT2	0.2	2.0
				PT3	0.2	2.5
Group Process (formative)	n/a	n/a	n/a	GP1	0.7	1.9
				GP2	0.4	1.9
Learning Outcome (formative)	n/a	n/a	n/a	LO1	0.5	1.2
				LO2	0.6	1.3
Ease of Use (reflective)	.68	.66	.52	EOU1	0.9	2.4
				EOU2	0.9	2.4
Use Intention	.77	.73	.62	IT1	1	1

Table 2: Psychometric properties of reflective and formative constructs

Assessment of Structural Model

The structural model was analyzed in three steps. First, the R-square of each of the endogenous latent variables was determined along with the most essential criteria. The path coefficients needed to be significant at the 0.05 level and the path weights to be more than 0.10 (Urbach and Ahlemann 1975).

PLS structural model results are shown in Figure 4 and summarized in Table 5. The model accounts for 32% of variance in the group process, 57% of learning outcome, and 45% of use intention.

	EaseOfUSe	GroupProcesses	ITPlatform	Intendtouse	LearningOutcome	Gender
EaseOfUSe	0.95					
GroupProcesses	-0.491	NA				
ITPlatform	-0.607	0.568	NA			
Intendtouse	-0.481	0.481	0.528	NA		
LearningOutcome	-0.578	0.686	0.747	0.652	NA	
Gender	0.06	-0.178	-0.025	-0.051	-0.024	NA

Table 3: Square root of AVE and Latent Variable Correlations

In the basic model of IT platform, group process, learning outcome, and use intention, all elements were significant. As shown in Figure 4, the effect of IT platform on group process was significant and positive ($\beta = 0.57$, $p < 0.001$), supporting Hypothesis 1. The effect of group process on learning outcome was significant and positive ($\beta = 0.49$, $p < 0.001$), supporting Hypothesis 2. The effect of learning outcome on use intention was significant and positive ($\beta = 0.57$, $p < 0.001$), supporting Hypothesis 3. The effect of ease of use on use intention was significant and positive ($\beta = 0.15$, $p < 0.01$), supporting Hypothesis 5. The effect of ease of use on learning outcome was significant and negative ($\beta = -0.36$, $p < 0.001$), *thus failing to support Hypothesis 4.*

	Age	EaseOfUSe	GroupProcesses	IT Platform	Intendtouse	LearningOutcome	Gender
EOU1	0.091	**0.953**	-0.524	-0.642	-0.475	-0.61	0.09
EOU2	0.081	**0.928**	-0.387	-0.486	-0.426	-0.463	0.016
LO1	0.013	-0.446	0.67	0.541	0.488	**0.838**	-0.093
IT1	-0.193	-0.481	0.481	0.528	**1**	0.652	-0.051
Gender	0.22	0.06	-0.178	-0.025	-0.051	-0.024	1
Age	1	0.092	0.019	-0.128	-0.193	-0.079	0.22
PT1	-0.135	-0.63	0.546	**0.961**	0.508	0.721	-0.034
PT2	-0.083	-0.384	0.443	**0.78**	0.471	0.602	0.026
PT3	-0.09	-0.467	0.483	**0.85**	0.388	0.606	-0.036
GP1	0.017	-0.49	**0.965**	0.553	0.444	0.658	-0.178
GP2	0.018	-0.392	**0.859**	0.479	0.452	0.597	-0.141
LO2	-0.141	-0.535	0.506	0.725	0.619	**0.866**	0.046

Table 4: Loadings and Cross Loadings

Conclusion

The goal of this paper was to identify how information technology (IT) promotes collaborative processes and if that leads to learning and acceptance. We found that an IT platform with certain performative and communicative features promotes collaboration activity directed toward tasks and commitment. This in turn led to improved learning and acceptance of the approach. However, the relationship between ease of use and learning was found to be negative. This is not surprising. Capdeferro and Romero (2012) have identified sources of frustration on the part of students and teachers during the collaborative process. Generation Z individuals who participated in the survey are unlikely to find Web 2.0 tools difficult to use, but may find the process unsatisfactory, and this could be the source of the negative correlation. There are many reasons why collaborative learning sometimes fails to deliver learning: students with different learning styles interacting among themselves, the problem of free riders, issues involved in cooperation across cultural boundaries, and so on (Jeong et al. 2014). These areas can be fruitful for future research in the CSCL field. The paper makes several theoretical contributions. It extends the use of Activity theory approach to collaborative learning. The approach used the interaction of technology features and group process features to drive the dependent variable of a successful outcome.

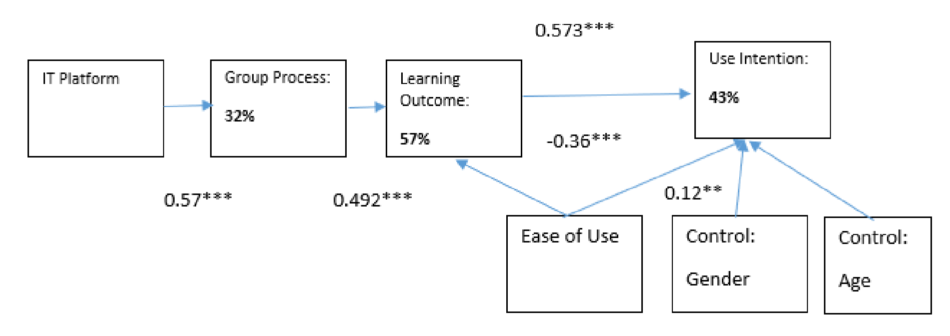

Figure 4: PLS test of the proposed structural model

***p< 0.001; **p<0.05

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Group Process R-square = 0.32 Learning Outcome R-square = 0.55 Use Intention = 0.45			
Path Effects	**Path Coefficient**	**T Statistics**	**P value /Result**
H1: IT Platform → Group Process	0.57	8.4	0.0001/ ****Significant*
H2: Group process → Learning Outcome	0.53	8.7	0.0001/ ****Significant*
H3: Learning Outcome → Use Intention	0.56	6.3	0.0001/ ****Significant*
H4: Ease of Use → Learning Outcome	- 0.32	4.1	0.0001/ ****Significant but negative sign*
H5: Ease of use → Use Intention	0.15	2.0	0.01/ ***Significant*
***p< 0.01; **p<0.05			

Table 5: Test of Hypotheses

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PT1	The IT platform allows quick exchange of ideas	Kuo et al. 2014
PT2	The IT platform allows me to comment on and edit others work	Kuo et al. 2014
PT3	The IT platform allows us to exchange feedback	Kuo et al. 2014
GP1	The platform promotes processes that help integrate our skills	Vuopala et al. 2016;West 2002
GP2	The platform promotes commitment to our group objectives	Vuopala et al. 2016;West 2002
EOU1	It is easy for me to use the eLearning platform	TAM model
EOU2	I find it easy to get the eLearning platform to do what I want it to do.	TAM model
LO1	The IT platform helps our group to be creative	Anders & Rolland, 1994
LO2	The IT platform is useful in academic life	Anders & Rolland, 1994
IU	I predict that I will participate in collaborative learning in the future	TAM model

Table 6: Indicator Sources & Definitions

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