User acceptance in a computer-supported collaborative learning (CSCL) environment with social network awareness (SNA) support

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Although many e-learning studies have applied the unified theory of acceptance and usage of technology (UTAUT) to investigate user acceptance, their findings have been inconsistent. One of reasons is that the user acceptance model of an e-learning system can be determined by the new information technologies (or mechanisms) the e-learning system utilises. Computer-supported collaborative learning (CSCL) with social network awareness (SNA) mechanisms has been widely adopted because it can enhance online collaborative learning effectiveness. Since new SNA mechanisms are expected to have a huge impact on user acceptance in CSCL environments, this study extends UTAUT to investigate user acceptance of an SNA CSCL environment. This study empirically evaluated the extended model by surveying 186 undergraduates, who had completed a 5-week electric commerce course in an SNA CSCL environment. The findings indicated that the SNA mechanism substantially strengthened the effect of social influence on behavioural intention to use the SNA CSCL system. Compared with other CSCL studies, the predictive power of social influence in this study was higher, while that of other determinants (i.e., performance expectancy and effort expectancy) in this study were lower. The extended model demonstrated higher explanatory power compared to models used in other CSCL studies.

Background

User acceptance studies for e-learning

Theoretical models used to investigate the determinants that affect the acceptance of information technologies include the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980) and the theory of planned behaviour (TPB) (Ajzen, 1991), as well as the technology acceptance model (TAM) (Davis, 1989). Many studies have used both the original and extended version of the theoretical models to explore students' acceptance of e-learning environments (Cheung & Vogel, 2013; Pituch & Lee, 2006; Roca & Gagne, 2008). The extension of the existing model could indicate that it is insufficient for explaining some aspects of user acceptance of e-learning (Cheung & Vogel, 2013).

Another renowned model is the unified theory of acceptance and usage of technology (UTAUT), which integrates the several theoretical models into a unified theoretical model to explain user intentions to use an information system and subsequent usage behaviour (Venkatesh, Morris, Davis, & Davis, 2003). The four key constructs in the UTAUT are: (1) performance expectancy (PE), (2) effort expectancy (EE), (3) social influence (SI), and (4) facilitating conditions (FC). As Venkatesh et al. (2003) defined, performance expectancy (PE) is the degree to which an individual believes that using the system will help his/her performance. Effort expectancy (EE) is the ease of using a system. Social influence (SI) is the degree to which an individual perceives that it is important others believe he or she should use the new system. Facilitating conditions (FC) describe the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the information system (Venkatesh et al., 2003). Additionally, behavioural intention (BI) is the degree to which an individual will adopt the information system in the future, while user behaviour (UB) is the degree to which the individual actually uses the information system (Venkatesh, 2000; Yueh, Huang, & Chang, 2015). Notably, Khechine, Lakhak, Pascot, & Bytha (2014) argued that the UTAUT model was proven to give a better explained variance of the intention to use technologies than previous models (i.e., TRA, TAM, and TPB).

E-learning studies based on the UTAUT model

Table 1 shows some UTAUT-based studies for user acceptance of e-learning. Lin, Lai, and Chang (2016) divided these e-learning systems into two types: learner-centered and CSCL. Within a learner-centered e-learning environment, students actively and solely complete learning tasks without peer support or collaboration (e.g., students learn independently from webpage materials). On the other hand, within a CSCL environment, students can collaboratively solve problems or acquire new knowledge through peer collaboration. Table 1 classifies these studies and lists their results of user acceptance.

Abubakar and Ahmad (2013) argued that studies that have used UTAUT to investigate technology adoption have yielded conflicting findings. According to the classification of learner-centered and CSCL, although most studies seem to have no identical results of user acceptance, some cues can still be found. Specifically, the reported impacts of PE on BI have similar conditions in both learner-centered studies and CSCL studies. That is, within the learner-centered studies, approximately half of the studies showed PE significantly affects BI, while half of those do not. The similar condition also happened within the CSCL studies. On the other hand, approximately half of the studies of learner-centered systems show SI significantly affects BI while half of those do not. In contrast, SI seems to have substantial influences on BI in most CSCL studies while seven out of eight CSCL studies show that SI significantly affects BI to use CSCL. Unlike individual (learner-centered) technology, which aims to improve individual productivity, group technology (CSCL) aims to facilitate group coordination and to support cooperation and collaboration among a group of users (Sun & Zhang, 2006). For example, in a CSCL environment users who have adopted the technology may have the incentive to enlist other users, and they may be eager to promote the technology with peers by sharing their experience with and further offering help to potential adopters. This in turn (SI) promotes their intention to use it (BI) (Lou et al., 2000; Sun & Zhang, 2006). Therefore, user acceptance of groupware (CSCL) differs from user acceptance of individual (learner-centered) technology due to the unique features of groupware (CSCL) (Lou, Lou, & Strong, 2000). Individual technology is relatively personal and may be driven less by social influences compared to group technologies (Davis, 1989; Sun & Zhang, 2006).

The inconsistencies suggest that some factors may affect the linkage between these constructs. Different technologies or system characters (e.g., learner-centered or CSCL) could be an important factor in user acceptance (Sun & Zhang, 2006; Van Raaij & Schepers 2008). Another example is that the common technologies (e.g., email, word processing software) are relatively easier to use than the specific technologies (e.g., database management system, telemedicine technology). Thus, perceived ease of use, which is equivalent to the UTAUT's effort expectancy, was found to have significant influences on behaviour intention (BI) for these specific technologies but not for these common technologies (Sun & Zhang, 2006). Few studies however, have focused on the effects of different technologies on user acceptance, which is worthy of further investigation (Sun & Zhang, 2006).

Table 1
Studies of two type of e-learning systems (i.e., learner-centered and CSCL) that investigate user acceptance based on the UTAUT

Ssystem type	Literature	Features	Surveyed on:	PE -> BI	EE -> BI	SI -> BI	FC -> UB
Learner-centered	Alrawashdeh, Muhairat, & Alqatawnah, (2012)	Examine employee acceptance of e-learning system in organisations.	Past experience (retrospect)	O	O	O	O
	Attuquayefio & Addo (2014)	Analyse predictors of student acceptance of e-learning.	Past experience (retrospect)	X	O	X	O
	Cheng, Yu, Huang, Yu, & Yu (2011)	Investigate mobile e-learning adoption among employees.	Past experience (retrospect)	X	X	O	N/A
	Deng, Liu, & Qi, (2011)	Identify factors in web based question-answer services (WBQAS) adoption.	Past experience (retrospect)	O	O	X	O
	Gao & Deng (2012)	Analyse factors in user acceptance of mobile e-books.	Past experience (retrospect)	O	O	X	X
	Tan (2013)	Evaluate how students use English E-learning websites.	Past experience (retrospect)	O	O	O	O
	Terzis & Economides (2011)	Evaluate how students use online assessment. Use the constructs: perceived usefulness, perceived ease of use, SI, BI.	Subjects used the online assessment system for 45 minutes.	X	O	N/A	N/A
CSCL	Godin & Leader (2013)	Identifying the factors that influence electronic collaboration technology acceptance (using a web-based video conferencing technology, WebEx) and predicted usage for virtual team collaboration projects in courses.	Subjects used WebEx for four-time virtual meetings.	O	X	O	O
	Hsu (2012)	Use Moodle for online discussions to assist English learning.	Past experience (retrospect)	O	O	O	X
	Ismail (2010)	Examine user acceptance while utilising Facebook amongst university students in Malaysia.	Past experience (retrospect)	O	O	O	O
	Liu & Huang (2015)	Examine the acceptance behaviour of online synchronous collaboration (using Google Doc) to support peer translation.	Subjects co-translated one English article	X	O	O	O
	Nistor, Schworm, & Werner (2012)	Evaluate use of online help system. Use active use intention as BI.	Subjects used the help system for six months	X	N/A	O	N/A
	Raman & Lateh, (2015)	Examine user acceptance while utilising Facebook as a communication tool and collaborative educational tool amongst secondary school students in Malaysia.	Past experience (retrospect)	X	X	X	N/A
	Sumak, Polancic, & Hericko, (2010)	Evaluate how students use Moodle as e-learning platform.	Past experience (retrospect)	O	X	O	O
	Yueh et al., (2015)	Students used Wiki systems, in which students were asked to discuss their team projects and collaboratively develop their learning and group work throughout the semester.	Subjects co-worked on one team project	X	X	O	X

Notes. O: significantly affect; X: insignificantly affect; for example, PE -> BI O means PE significantly affect BI. N/A: the article did not specify the details

CSCL with social network awareness (SNA)

Social network awareness (SNA) is defined as the ability of a student to perceive the knowledge context of peers (i.e., the proficiency level of a specific domain and knowledge level of peers) and the social context of peers (e.g., social relationship and social interaction) within a CSCL environment (Chen & Chang, 2014; Lin & Lai, 2013; Lin, Mai, & Lai, 2015; Sangin, Molinaru, Nussli, & Dillenbourg, 2011). Many studies have asserted that a deep mutual awareness among peers enables fluid and expressive communication between individuals, resulting in a more effective coordination of ideas, opinion exchange, and actions (Lin & Lai, 2013; Lin et al., 2015). Thus, many studies have added the SNA mechanism in a CSCL environment to unveil the knowledge context and social context of peers back to a learner. That is, CSCL with an SNA mechanism (herein, called SNA CSCL) is widely used for problem-based learning, project-based learning, or online assessment (Chen & Chang, 2014: Kimmerle & Cress, 2008; Lin & Lai, 2013; Lin et al., 2015; Lin & Tsai, 2016; Sangin et al., 2011). For example, Chen and Chang (2014) presented a SNA system capable of unveiling peers' past social interaction in a cooperative problem-based learning (PBL) environment. Lin and Lai (2013) used an SNA tool (revealing peer's social relationship, willingness degree to help, and knowledge degree) for an online formative assessment. The result shows that SNA can stimulate students to participate formative assessments and increase opportunities of knowledge sharing. Sangin et al. (2011) investigated an SNA CSCL system capable of visualising the learning partners' levels of prior knowledge, and the results showed that the system can enhance communication quality.

Research aims

The results of the UTAUT (Table 1) may also be determined by new or different technologies (mechanisms). Sun and Zhang (2006) stated that new technologies often involve factors that are rarely considered but could play an important role in user acceptance of a new technology. For example, Terzis, Moridis, and Economides (2012) added the mechanism of emotional feedback (e.g., sad and happy voices and facial expressions) to learners who had completed an assessment and further investigated whether emotional feedback significantly increased their behavioural intention to use an online assessment. Liu, Liao, and Pratt (2009) suggested that models for e-learning adoption should consider the nature of the technology since not all perceptions (e.g., factors in the UTAUT) may be salient for all technologies. The SNA CSCL is an emerging e-learning technology that has proven effective for enhancing collaborative learning in online environments. However, few studies have investigated user acceptance of an SNA CSCL environment.

In this study, students could use the SNA CSCL environment to conduct online assessments and further, ask peers for help when incorrectly answering assessment questions. The SNA mechanism supported students asking for help by providing: (1) peers' knowledge context (e.g., knowledge degree); (2) peers' social context (e.g., close friend or not, the number of help requests); and (3) learning activity context (e.g., the number of system access). To investigate user acceptance of the SNA CSCL, this study extended the UTAUT by adding the SNA determinant in the UTAUT model. Sykes, Venkatesh, and Gosain (2009) suggested that observing interaction among users seeking and providing help related to a system can reveal relationships between peer interaction and system usage, therefore study tried to understand how the SNA and online peer interactions (help seeks and responses) influence behavioural intention.

Model and hypotheses

As suggested by Raman and Lateh (2015) and Tan (2013), we did not consider the moderating effects of age and experience in UTAUT because this experiment was performed at a Taiwan University in which ages of all participants and there CSCL experiences were similar. Additionally, the moderating effects of voluntariness in UTAUT were not considered in this study because all subjects were free to use the SNA CSCL system (e.g., free to conduct online assessments and free to assist each other). Figure 1 shows the proposed model.
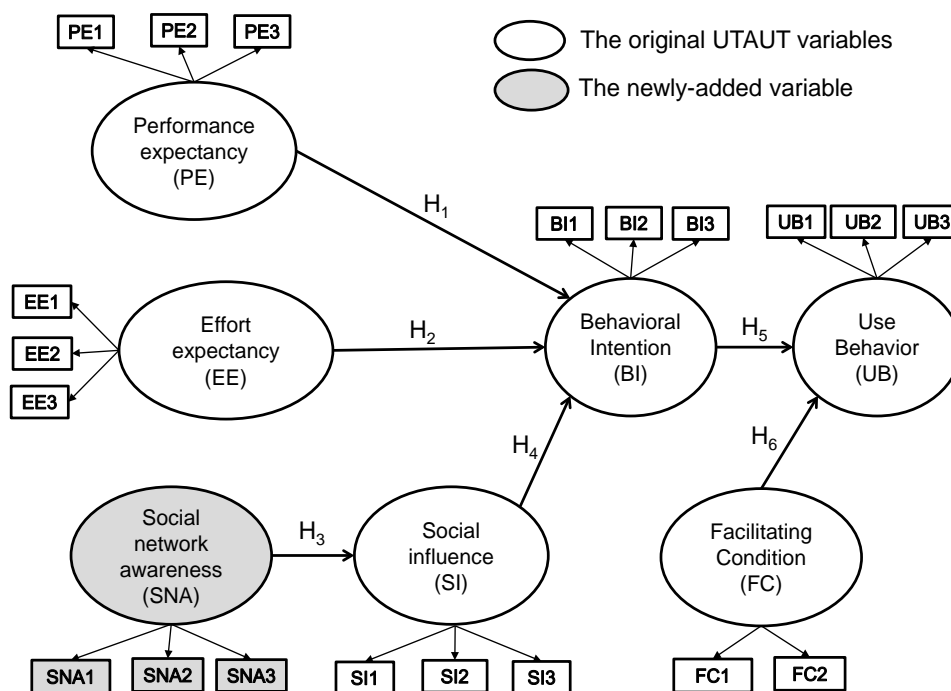
Figure1. Research model and hypotheses

Effect of performance expectancy (PE)

According to Yueh et al. (2015), PE is constructed if students perceive a CSCL tool (e.g., Wiki) as useful in completing their group term report. Hsu (2012) found that PE positively correlated to BI when using Moodle for CSCL to assist English learning. Ismail (2010) also found that PE was positively associated with BI while utilising Facebook for CSCL among university students in Malaysia. Additionally, for online assessment studies, Terzis and Economides (2011) stated that learners believed an online assessment system could improve their knowledge, comprehension, and performance for the course. The proposed SNA CSCL is an online collaborative learning environment, enabling students to conducting online assessment and assist each other when encountering problems. Thus, hypothesis 1 in this study was:

> H1: Performance expectancy significantly influences behavioural intention within the SNA CSCL environment.

Effect of effort expectancy (EE)

This study defines effort expectancy as the degree to which the user believes that using the SNA CSCL would not require effort (Cheung & Vogel, 2013). Davis (1989) assumed that a system that is perceived as simple or easy to use would be more likely to induce users' perceptions of usefulness and behavioural intentions to use it. Hsu (2012) and Ismail (2010), individually adopted Moodle and Facebook for CSCL, and both found that EE positively correlated to BI. Regarding online assessment studies, Terzis and Economides (2011) found that EE positively associated with BI. Since the proposed SNA CSCL is an online assessment environment with peer assistance, hypothesis 2 in this study was:

> H2: Effort expectancy significantly influences behavioural intention within the SNA CSCL environment.

Effect of the social network awareness (SNA) mechanism

The SNA mechanism is applicable when: (1) the social and knowledge patterns of others can be identified by the student; and (2) the social and knowledge patterns of the student can be identified by others. The first means the SNA mechanism offers opportunities for the student to compare whether his/her learning

strategies are more appropriate than others (Lin et al., 2016). Bodemer (2011) stated that SNA mechanism can be interpreted as providing tacit guidance to a learner to adjust his/her learning strategies. The second means the SNA mechanism may constrain the learning behaviour of a student because an individual presents positively when their behaviour can be observed by others in order to avoid being perceived negatively (Kimmerle & Cress, 2008). Clearly, the SNA mechanism should substantially affect the behaviour intention of an individual through peer influence. This study further assumes that the SNA mechanism strengthens social influence on the BI of an individual.

The tradition of adding variables is common in research on UTAUT, and the approach advocated by some researchers is to extend UTAUT to CSCL (Godin & Leader, 2013; Nistor et al., 2012; Yueh et al., 2015). Sun and Zhang (2006) stated that when the context is highly complex, additional factors are needed to capture the added complexity. In this study, the SNA, as an added variable, appeared to be a significant determinant of social influence. This might help explain the strong effect that SNA had on social influence. Thus hypothesis 3 in this study was:

H3: SNA significantly influences social influence within the SNA CSCL environment.

Effect of social influence (SI)

Yeh, Lin, and Lu (2011) argued that SI is a significant predictor of BI in technology acceptance. Furthermore, Hsu (2012), Nistor et al. (2012), and Sumak et al. (2010), who all adopted the Moodle online help system, and Moodle for CSCL, showed SI positively predicted BI. For online assessment studies, Terzis and Economides (2011) stated that students consider the opinions of their colleagues, their friends and their seniors about the perceived usefulness and the added value of online assessment system. Terzis and Economides (2011) further found that SI had a direct effect on perceived usefulness. Thus, hypothesis 4 in this study was:

H4: Social influence positively influences behavioural intentions within the SNA CSCL environment.

Effect of behavioural intention (BI)

BI reflects the motivational influences that drive an individual to perform a behaviour (Sykes et al., 2009). Ajzen (1991) also suggested that, as intention increases, the individual tries harder to perform the behaviour. In IT fields, BI to perform a behaviour has shown a strong association with use behaviour. Reported correlations between constructs approximate .50 (Sykes et al., 2009; Venkatesh et al. 2003). Thus, hypothesis 5 in this study was:

H5: Behavioural intention to use a system positively influences use behaviour.

Effect of facilitating condition (FC)

This study defines FC as support given during the online assessment (Terzis & Economides, 2011). For example, an instructor has to be present during online assessment to attend to students' queries regarding the use of online assessment. Ismail (2010) found that FC positively associated with BI while utilising Facebook for CSCL. Sumak et al. (2010) found that FC is significantly related to use of Moodle for CSCL. Thus, hypothesis 6 in this study was:

H6: Facilitating condition positively influences use behaviour.

Research methodology

The SNA CSCL system used

The design concept of our SNA CSCL system originated from Lin and Lai (2013). The system is capable of allowing students to be aware of peer's social context; students can assist each other when encountering problems on online assessments. More specifically, the students received online assessments after completing a lesson in class. Figure 2 illustrates the system design. The students then received the results,

but the correct answer was not provided if they failed to answer the question. For each question answered incorrectly, a student could click the corresponding button called "looking for peer assistance" to generate the candidate list. These candidates (peers) all answered the question correctly. In particular, these candidates were displayed with their specific context to provide a reference for the student (help seeker). The specific contexts include: (1) social context: social relationship (i.e., close friend or not), the number of help requests, and willingness degree to help the others; (2) knowledge context: extent of knowledge; and (3) learning activity context: the number of system accesses and the total duration of all system accesses. Additionally, the system also ranked students in terms of enthusiasm for helping peers. The design ensured that students were aware of these contexts during peer assistance. Students could then select the desired helpers from the list and send help messages. Upon a helper responding to a request, the help seeker received a notification e-mail from the system, which contained a hyperlink linking to the new response (visible only to the seeker). The student could also log into the system to check for new responses and review historical assessments.

The SNA CSCL system used the following measures to acquire the social context. Students were required to establish social relationships through the SNA CSCL system in advance (Lin & Lai, 2013). In practice, a close friendship between two peers is established when both acknowledge the relationship (similar to the functions of friend request and acceptance in Facebook). The system also analysed participant preferences by recording participant activities as logged data (e.g., login time). Specifically, the system recorded message flow among peers, including help requests, help responses, and response rates. For each student, the response rate (defined as the willingness to help others) was calculated by dividing the number of help requests to which student responded by the number of help requests a student received.
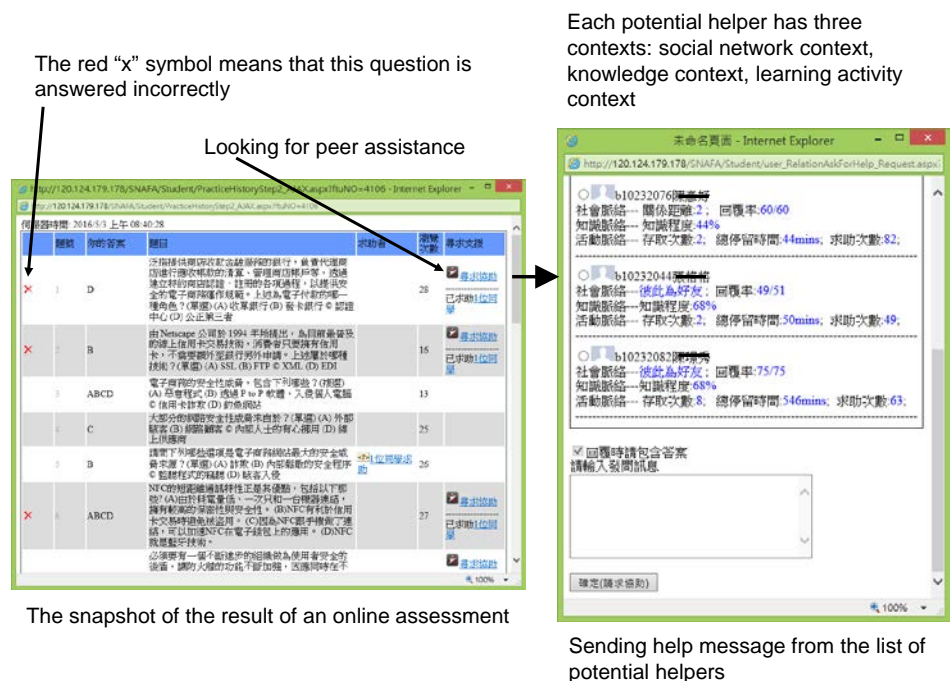

Figure 2. The SNA CSCL assessment system

Participants and course

The experiment was administered to a total of 186 students from three third-year classes of undergraduates at a Taiwan university. The students were aged between 19 and 21. The duration of the experimental subject, Electric Commerce, was a full semester, with a 2 hour per week class. The experimental subject had five learning objectives, each with a corresponding assessment. Each assessment contained around 30 multiple-choice questions based on the teaching material. This subject was a compulsory course. No participants had attempted the subject before. Prior to the experiment, students in all classes were informed that their classes would be partially delivered using some instructional methods as an experimental intervention. The students

were also informed that data would be anonymously collected and analysed. A student had the freedom to drop his/her class allocation and take another teacher's class allocation, if preferred.

Instrument

The survey instrument used to test the research model included the seven constructs: PE, EE, SI, FC, BI, UB, and SNA. Appendix A shows the constructs, the related questionnaire items, the operational definition of each item, and their sources. For example, PE included three items which referred to Chen & Huang (2012). All items were measured on a 5-point Likert scale ranging from 1 - *strongly agree* to 5 - *strongly disagree*.

Experiment and data collection procedures

Before the experiment, all students received 1 week of training and practice in using the SNA CSCL. Students first individually registered their personal information and then set their friendship (i.e., social relationship). We set a 1 week period for each lesson to indicate learning length expectation. Specifically, after receiving the face-to-face teaching of one lesson in 1 week, students then could take the corresponding online assessment using the SNA CSCL during that week. Meanwhile, students could request and respond to help when encountering problems on assessments, as shown in Figure 2. Since the experimental course comprised five lessons (and five corresponding assessments), all students completed the above procedures five times over 5 weeks. The experiment was designed to be long enough for students to develop learning behaviours as they became familiar with the system over an extended period of time (Lin et al., 2015). At the end of the experiment, all students completed a post-test of the survey questionnaire (Appendix A).

Results

The system logs showed that the number of help requests for the five online assessments were 86, 96, 133, 182, and 178, respectively, while the number of help responses were 66, 79, 116, 172, and 168, respectively. Thus, the average response rates for the five online assessments were 76%, 82%, 87%, 94%, and 94%, respectively. The number of help requests and the response rates consistently increased as the experiment progressed; particularly, the response rates reached 94% at the fifth assessment.

The sample size plays an influential role in the reliability test and in structural equation model (SEM) analysis. Bollen (1989) recommended a minimum sample size of at least 100. After removing invalid questionnaires (e.g., any questionnaire with blank answers or where all answers were the same), the number of valid questionnaires was 168, meeting the requirement of SEM minimum sample size. Of the 168 valid questionnaires, 52 were completed by male students (30.9%) and 116 by female students (69.1%).

This study used a two-step approach to structural equation modelling (SEM) analysis. After performing confirmatory factor analysis (CFA) to validate the measurement model, the structural model was used to test the hypotheses (Anderson & Gerbing, 1988). The AMOS 20 software was used for the SEM analysis in this study.

Measurement model

According to Pituch and Lee (2006), each construct should be measured by at least two items. If a construct only has two items, the items should be similar to the items used by other researchers to measure the constructs. In this study, except for the facilitating condition, all other constructs consisted of three items (Appendix A). The facilitation condition was measured with two items (i.e., FC1 and FC2), which had been used in earlier studies by Attuquayefio and Addo (2014), Terzis and Economides (2011), and Terzis, Moridis, and Economides (2012). The measurement model had an acceptable fit and acceptable psychometric properties, and each item was strongly related to its respective factor (i.e., factor loading), as described below.

The measurement model was validated by means of the confirmatory factor analysis. Overall, the measurement model showed a good model-data fit: χ^2/df ratio = 1.59; normed fit index (NFI) = 0.97; non-normed fit index (NNFI) = 0.99; comparative fit index (CFI) = 0.98; and root mean square error of

approximation (RMSEA) = 0.03. All of these model-fit indices exceeded the minimum values suggested in the literature (Chow, Herold, Choo, & Chan, 2012).

This study then examined reliability, convergent validity, and discriminant validity (Chow et al., 2012). The composite reliability (CR) and Cronbach's alpha of the constructs were used to examine reliability. As shown in Table 2, they all exceeded the acceptable criterion of 0.60, meaning that the scales had good reliabilities (Bagozzi & Yi, 1988).

Table 2
Descriptive statistics, average variance extracted (AVE), composite reliability (CR) and factor loading of construct measurement

Variables	*M*	*SD*	Factor loading	*t*-value	AVE	CR	Cronbach's alpha
Performance expectancy	4.38	.634			0.66	0.85	0.85
PE1	4.41	.660	0.90	9.52*			
PE2	4.31	.772	0.76	7.69*			
PE3	4.41	.729	0.78	8.02*			
Effort expectancy	4.15	.760			0.60	0.81	0.78
EE1	3.82	1.060	0.59	5.49*			
EE2	4.28	.854	0.78	7.38*			
EE3	4.34	.795	0.91	8.66*			
Social influence	4.22	.713			0.62	0.83	0.83
SI1	4.25	.800	0.88	8.92*			
SI2	4.25	.830	0.68	6.62*			
SI3	4.18	.848	0.79	7.89*			
Facilitating condition	4.21	.786			0.63	0.83	0.82
FC1	4.11	.862	0.81	7.51*			
FC2	4.29	.813	0.77	7.46*			
Behavioural intention	4.12	.705			0.62	0.83	0.83
BI1	4.15	.809	0.86	8.68*			
BI2	4.27	.762	0.72	7.09*			
BI3	3.93	.870	0.78	7.72*			
Use behaviour	4.10	.664			0.53	0.77	0.77
UB1	4.28	.734	0.83	5.31*			
UB2	4.00	.900	0.61	4.06*			
UB3	4.01	.994	0.73	4.41*			
Social network awareness	4.02	.835			0.70	0.87	0.88
SNA1	4.01	.880	0.92	10.34*			
SNA2	4.02	.886	0.80	8.49*			
SNA3	4.04	1.029	0.79	8.31*			

* $p < .05$

Unidimensionality and average variance extracted (AVE) were used as indicators of convergent validity (Bagozzi & Yi, 1988; Chow et al., 2012). Unidimensionality was assessed in terms of factor loading and *t*-value of items (Chow et al., 2012). Table 2 shows that the factor loadings of the items of the seven factors model ranged from 0.59 to 0.92 and their *t*-values were significant at the level of p < 0.05. All factor loading values exceeded the recommended benchmark of 0.50 (Hair, Anderson, Tatham, & Black, 1992). All AVEs also exceeded the threshold value of 0.50 (Hair et al., 1992).

Discriminant validity was tested by comparing the square root of the AVE of each construct and its correlation coefficients with other constructs (Chow et al., 2012). Table 3 presents the results for comparison. For all the constructs, the square roots of the AVEs were larger than the correlation coefficients with other constructs, thus showing good discriminant validity (Fornell & Larcker, 1981). In summary, all constructs in the measurement model had adequate reliability, convergent validity, and discriminant validity.

Table 3
Square root of average variance extracted (AVE) and correlations of all constructs

		1	2	3	4	5	6	7
1.	Performance expectancy	**0.81**						
2.	Effort expectancy	0.51	**0.77**					
3.	Social influence	0.62	0.53	**0.79**				
4.	Facilitating condition	0.60	0.50	0.72	**0.78**			
5.	Behavioural intention	0.61	0.51	0.74	0.69	**0.79**		
6.	Use behaviour	0.51	0.48	0.71	0.68	0.70	**0.73**	
7.	Social network awareness	0.61	0.44	0.64	0.67	0.71	0.64	**0.84**

Note: Square roots of AVEs are shown as diagonal elements in bold type. The diagonal elements were greater than the corresponding off-diagonal elements in the same row and column, indicating the discriminant validity.

Structural model

Hypothesis testing was performed in the context of the structural model. Figure 3 presents the properties of the causal paths, including standardised path coefficients, *p*-values, and variance explained for each equation in the hypothesised model. Not all hypotheses were supported because the path coefficients for H1, H2, and H6 were not significant at the level of $p < .001$. However, social network awareness had a significant positive effect on social influence and accounted for 64% of the variance in social influence. Social influence had a significant positive effect on use intention and accounted for 87% of the variance in behavioural intention. Behavioural intention had a significant positive effect on use behaviour and accounted for 98% of the variance in use behaviour. Social influence moderates the relationship between social network awareness and behavioural intention. Notably, within the SNA CSCL, social influence has most prominent impacts on behaviour intention (beta = 0.91), compared with performance expectancy and effort expectancy.
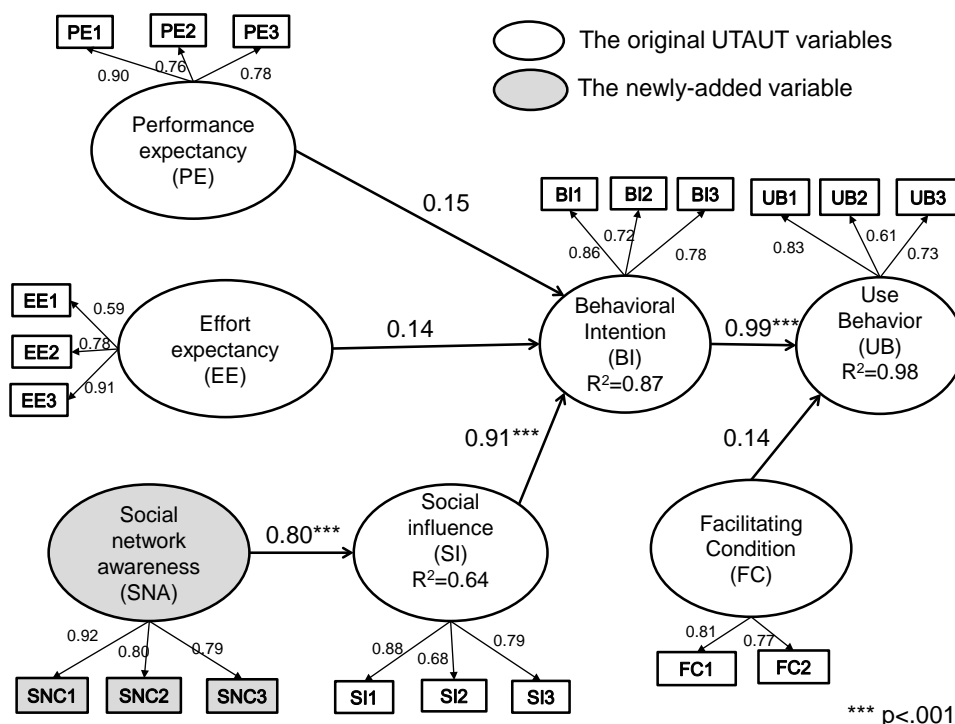

Figure 3. Results of structural equation model testing

Table 4 summarises the direct, indirect, and total effects of performance expectancy, effort expectancy, and social network awareness on social influence, behavioural intention, and use behaviour. Among all the predictor variables, behavioural intention had the strongest total effect on use behaviour (0.99), followed

by social influence (0.90), and social network awareness (0.72). Notably, the social network awareness effect exhibited a strong direct effect on social influence (0.80), and a strong indirect effect on behavioural intention (0.73) and use behaviour (0.72). Social influence had a strong direct effect on behavioural intention (0.91) and a strong indirect effect on use behaviour (0.90).

Table 4
Square root of average variance extracted (AVE) and correlations of all constructs.

	Direct effect			Indirect effect			Total effect		
	Social influence	Behavioural intention	Use behaviour	Social influence	Behavioural intention	Use behaviour	Social influence	Behavioural intention	Use behaviour
Social network awareness	0.80				0.73	0.72	0.80	0.73	0.72
Social influence		0.91				0.90		0.91	0.90
Behavioural intention			0.99						0.99

Discussion and conclusion

Factors affecting continuous SNA CSCL use intention

The SNA CSCL is a widely used and pervasive e-learning technology that enhances online collaborative learning effectiveness. However, few studies have investigated the determinants of SNA CSCL technology adoption. Based on the UTAUT, this research identified underlying factors that affected the intentions of students to use SNA CSCL. The results showed that the extended UTAUT explained 87% of the variance in behavioural intention, which was higher (i.e., the explanatory power of the model is higher) than those of other CSCL studies (Table 1), for example, Liu and Huang (2015) (73%), and Nistor, et al. (2012) (21%). This high value also demonstrates that the extended UTAUT captured some of the unique contextual features of SNA CSCL.

Notably, social influence was a more accurate predictor of intention to use the SNA CSCL system (beta = 0.91) compared to other CSCL studies, for example, Liu and Huang (2015) (beta = 0.26), Nistor et al. (2012) (beta = 0.26), Sumak et al., (2010) (beta = 0.24), and Yueh et al., (2015) (beta = 0.39). Additionally, although Venkatesh and Morris (2000) found that the effect of subjective norms (counterpart: social influence) on behavioural intention may weaken over time, this may be a different story within a SNA CSCL environment.

The possible reasons are as follows: (1) the CSCL environment was supported by SNAs, and (2) participants iteratively experienced collaboration processes for an extended period. The SNA tool enables: (1) a student to be aware of the social and knowledge patterns of others (as guideline references), and (2) the social and knowledge patterns of the student to be identified by others (i.e., behaviour properly to avoid negative perception). Improved mutual awareness among peers during collaborative learning causes them to reflect on their learning (Lin et al., 2016). For example, a student who notices that most requests elicit friendly responses may have higher than average willingness to request help. In contrast, an individual who notices that he/she has many requests not responded to and his/her response rate can be known by peers, might respond others' requests to avoid negative perceptions (Lin & Lai, 2013). That is, an individual might manifest an intention to comply with the social pressure under such circumstances. Previous data showed that the number of help requests and the response rates consistently increased as the experiment progressed,

which indicates a positive cycle of interaction among the students within the SNA CSCL. The above phenomena may explain why SNA tools significantly affect behaviour intention through social (peer) influence. When learners were iteratively immersed in assessments and peer assistance, social influence eventually become a more powerful determinant of their behaviour intention compared to findings in other CSCL studies.

Moreover, the used SNA CSCL platform was easy for students to use since they were already familiar with it at the later period of the experiment. Venkatesh et al. (2003) argued that the effect of effort expectancy is significant only during the first use, and became non-significant over periods of extended and sustained use. Inexperienced users are mainly concerned with ease of use (i.e., effort expectancy), and as experience increases, users presumably overcome concerns about ease of use (Escobar-Rodriguez & Monge-Lozano, 2012). Cheung and Vogel (2013) further stressed that social influence (i.e., subjective norms) can reduce the power of other predictors to predict behavioural intention with passing of time. As more peers join a platform, intention becomes unconsciously directed by peers: as the effect of peer influence increases, the relationship between behavioural intention and other predictors may weaken.

Implications in adopting SNA CSCL for learning practice

One problem with formative assessment is the low rate of participation by students, which in turn downgrades learning achievements (Lin & Lai, 2013). Thus, a teacher can apply the SNA mechanism in an online assessment system for courses to sustain students' participation rate and learning effectiveness. Through online assessments, students can identify their weaknesses and the parts of the lesson they did not understand, and further address these challenges through online peer assistance after an in-class lesson. It benefits not only current lesson learning, but also next lesson learning because without prior knowledge of preceding lessons, students typically have difficulty in understanding new concepts of subsequent lessons (Ausubel, 1968). As the course progresses and more assessment is conducted, the increasing interaction among peers could also induce sustained learning and further enhance the learning achievement (Lin & Lai, 2013).

Implications for the proposed model

Notably, our findings reveal that while investigating the user acceptance of a new e-learning technology based on the UTAUT (or other models), the technology possibly causes new technology-related determinants to influence behaviour intention and even strengthen (or diminish) the predictive powers of the existing determinants (e.g., effort expectancy). Additionally, Lin and Tsai (2016) expressed that the SNA mechanism could significantly enhance the quantity of personal contributions and peer interactions within the CSCL project-based learning environment. This is possibly because the SNA mechanism may strengthen the impact of social influence on behavioural intention to share individual knowledge or contribute individual effort in a CSCL project-based learning environment. Thus, our model results should be applicable to a CSCL project-based learning environment with SNA support.

Limitation and future work

Wang (2011) cautioned that the e-learning environment may only temporarily affect student learning. Lin and Tsai (2016) also found that a CSCL has different time-length effects (i.e., temporary or sustainable effect) on individual with different traits. These statements are in line with Venkatesh et al. (2003) who stated that effort expectancy may be pivotal at first and become less important as time goes by. In other words, some constructs may initially have significant effects on behaviour intention and later become trivial. Thus, this study could have benefited from performing the questionnaire survey immediately after the initial use of the SNA CSCL by students, and also at more time intervals. Such findings might enhance our understanding of the causality and interrelationships between the variables at different time points (Chow et al., 2012). Finally, further studies are advised to identify additional decomposed constructs, such as computer self-efficacy (Chow et al., 2012), individual difference, or prior experience (Escobar-Rodriguez & Monge-Lozano, 2012), each of which could further explain students' motivational perceptions and provide further insight into the determinants of SNA CSCL.

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Appendix
Questionnaire items

Constructs	Items	Operational definition	Sources
Performance expectancy	PE1	I find that the system improves my learning performance.	Chen & Huang (2012)
	PE2	Using the system increases my learning effectiveness.	
	PE3	Using the system enables me to achieve a high academic performance.	
Effort expectancy	EE1	Learning to operate the system is easy for me.	Chen & Huang (2012)
	EE2	I can easily become skillful at using the system.	
	EE3	The system has a clear and friendly user interface	
Social influence	SI1	Classmates who are important to me affect my use of the system.	Chen & Huang (2012)
	SI2	Classmates can know my learning status through the SNA system and that influences my behaviour to use the system.	
	SI3	Classmates can know whether or not I have replied to requests, which motivates me to reply to requests.	
Facilitating condition	FC1	When I need help to use the system, someone is there to help me.	Attuquayefio & Addo (2014); Terzis & Economides (2011); Terzis, Moridis, & Economides (2012)
	FC2	When I need help to learn to use the system, system's help support is there to teach me.	
Behavioural intention	BI1	I intend to use the system to improve my learning effectiveness in the future.	Tan (2013); Terzis & Economides (2011)
	BI2	I plan to use the system to improve my academic performance in the following chapters.	
	BI3	In the future, I intend to observe peers' learning status through the system.	
Use behaviour	UB1	I frequently use the system for assessment before the midterm.	Cheung and Vogel (2013); Lin & Lai (2013)
	UB2	I often observe the learning status of peers through the system before the midterm	
	UB3	I often review the online assessments before the midterm.	
Perception of SNA	SNA1	This system provides information about the learning context and status of peers.	Lin & Lai (2013)
	SNA2	This system provides information about the knowledge level of peers.	
	SNA3	This system enables me to know peers' learning interaction, such as help requests and response.	