Modeling Learner Situation Awareness in Collaborative Mobile Web 2.0 Learning

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ABSTRACT

The concept of situation awareness is essential in enhancing collaborative learning. Learners require information from different awareness aspects to deduce a learning situation for decision-making. Designing learning environments that assist learners to understand situation awareness via monitoring actions and reaction of other learners has been reported to be beneficial in enhancing collaborative learning. An emerging learning mode is mobile Web 2.0 learning where Web 2.0 tools support mobile learning – allowing for personalization, ubiquity and social connectivity in learning. Thus, the study investigates and models learner situation awareness in collaborative mobile Web 2.0 learning. Participants were novice teacher trainees in a local university. The study was conducted over a four-month period. Data were collected via questionnaires and analyzed by PLS-SEM analysis. The results revealed that learner situation awareness in collaborative mobile Web 2.0 learning is reflected by six factors: learning reflection, learning space, learning community, social, task, and personal awareness. Results also showed that learners perceived learning reflection awareness as the most important factor.

Keywords: *Learner situation awareness, collaborative mobile Web 2.0 learning, learning reflection awareness, novice teacher trainees, higher education*

INTRODUCTION

An interesting mode of learning utilizing the advancement of global mobile and sensor technology is the mobile learning mode. The ubiquity and the connectivity of wireless mobile devices as well as mobile Web 2.0 technology allows for disruption of traditional teaching and learning practices – serving as catalysts for pedagogical change from an instructor-delivered content toward student-generated content via peer collaboration (Ally, 2009; Cochrane, 2014; Kukulska-Hulme, 2010). Mobile Web 2.0 enables mediation of student-generated learning context and content, which underpins a basis for students to work in collaborative teams to encourage critical thinking with appropriate scaffolding by instructors (Cochrane, 2014). This shows a huge potential in implementing these technologies in the current global and local education sector (Ally and Samaka, 2013; Din et al., 2012; Nordin et al., 2010; Siraj and Norman, 2012). Recent research has demonstrated that mobile Web 2.0 has the potential for supporting student collaboration in social networks besides facilitating student-generated content (Cochrane, 2014). Mobile Web 2.0 utilizes mobile-optimized Web 2.0 tools as a platform for engaging students and instructors in learning conversations within authentic learning environments. It also has the potential to integrate personalized learning as well as ubiquitous social connectedness in a pedagogical design learning context (Cochrane, 2014; Cochrane and Bateman, 2010).

Because mobile Web 2.0 learning is different from the traditional mode of learning, it requires different teaching and learning approaches to utilize or enhance its potential (Cochrane, 2014; Keskin and Metcalf, 2011). Although many studies have approached mobile learning from the computer-supported collaborative learning (CSCL) and computer-supported collaborative work (CSCW) point-of-view, yet few studies model/frame/investigate mobile Web 2.0 learning from the perspective of situation awareness (Cochrane, 2014; Phielex et al., 2011). Situation awareness is defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley, 2000). In cognitive science, situation awareness is defined as "in-between state" of the decision-making process as one "makes-sense" or deduces a situation in order to make an appropriate decision (Artman and Garbis, 1998; Belkadi et al., 2012).

The concept of situation awareness is usually investigated in complex environments such as aviation, cyber security, intelligent systems, complex operational environments, and medicine (Bolstad et al., 2010; Dutt et al., 2013; Miller and Trappe, 2010; Melander and Sahlstrom, 2009). For example, in aviation, Melander and Sahlstrom (2009) investigated pilots' capability to correctly perceive and interpret a situation with situation awareness. Although situation awareness is usually investigated in complex environments, learning environments can also be considered as complex environments (Van Merriënboer & Kirschner, 2012). Studies that apply situation awareness in learning environments include the works of Jacobsen et al. (2011) and Spector et al. (2013) where the former investigated scaffolding of learning in complex systems, while the latter studied knowledge construction in complex domains. However, although there is a significant amount of work on situation awareness in learning, there is a noticeable gap in studies of situation awareness in mobile learning, especially in mobile Web 2.0 learning. Thus, in this study, we investigate learner situation awareness in collaborative mobile Web 2.0 learning environments. As such, we developed a mobile Web 2.0 learning environment called Mobi2Learn (**Mobi**le Web **2**.0 **Learn**ing) to assess learner situation awareness in collaborative mobile Web 2.0 learning settings.

Review of Literature

This study originates from the context model of Kofod-Petersen and Cassens (2006). Belkadi et al. (2012) suggested the terms "situation" and "context" can be used interchangeably because "context" or "contextual information" is usually closely associated with supporting "situation" awareness. In relation to context, De Araujo et al. (2004) defined "context" as information that is used to characterize the task of the group – in which the information offers conditions for team members to become aware and understand all the factors influencing their interaction before making a decision on how to interact. This can be linked to Schmidt's (2002) definition of "situation", where the author defines "situation" as a meaningful space where cooperating workers act and interact among themselves. As there is a link between the concepts of "situation" and "context", we have attempted to model learner situation awareness in collaborative mobile Web 2.0 learning using the "context" model of Kofod-Petersen and Cassens (2006).

Before moving in depth on Kofod-Petersen and Cassens's (2006) model, we review the frameworks and models related to "collaborative mobile learning". Integration of technology in collaborative settings usually involves implementing the approaches of computer-supported collaborative learning (CSCL) and computer-supported collaborative work (CSCW) (Belkadi et al., 2012; Janssens and Bodemer, 2013). Past CSCL models include works by Stahl (2004) and Janssens and Bodemer (2013), where the former emphasized group cognition while the latter stressed the importance of distinguishing between cognitive and social awareness.

The emergence of mobile technology has further expanded collaborative learning opportunities. Although previous researchers have classified mobile learning as an extension or "sub-set" of e-learning (or CSCL), however, recently, educators have defined mobile learning as a separate mode of learning as compared to e-learning or CSCL (Traxler, 2009). The more recent definition of mobile learning is learning that is defined by the "mobility" state of learners in which they can access their personalized learning environment as they physically move (Kukulska-Hulme, 2010; Sharples et al., 2010; Traxler, 2009). Since there seems to be a distinction between mobile learning and e-learning (CSCL), there is a need for developing frameworks and models that address mobile learning under collaborative settings termed "collaborative mobile learning" (Ryu and Parsons, 2012).

Recent works in collaborative mobile learning include works of Buchem et al. (2012) and Ryu and Parsons (2012). Buchem et al. (2012) studied the integration of collaborative mobile learning into the university's curriculum via participatory curriculum development. The study included students as curriculum developers and identified several potential implications and challenges to implement such mode of learning. Ryu and Parsons (2012) investigated the social flow in collaborative mobile learning. They discovered that collaborative mobile learning has the potential to enhance learning via dynamic interaction among group learners.

However, there seems to be a gap in previous studies regarding collaborative mobile learning (CML). First, although a number of studies address learner situation awareness in CSCL and CSCW, only limited studies have examined CML in relation to learner situation awareness. Second, there is an inadequacy in terms of developing frameworks that address learner situation awareness, which are analyzed and verified with quantitative modelling techniques such as structural equation modelling (SEM). In order to address these issues, the *context* model of Kofod-Petersen and Cassens (2006) was selected in modelling learner situation awareness for collaborative mobile Web 2.0 learning. The model could be of value for understanding the aspects involved during collaborative mobile Web 2.0 learning settings. The model is based on "activity theory", used by many in the mobile learning community to describe human activity.

Research Model and Hypotheses

The context model of Kofod-Petersen and Cassens (2006) as the basis of analysis

This study is part of a larger study on modelling learner situation awareness in collaborative mobile Web 2.0 learning. The larger study involved two parts: (i) development of the learner situation awareness model for collaborative mobile Web 2.0 learning using qualitative analysis (i.e., thematic analysis); and (ii) the analysis of the developed model using quantitative measures via PLS-SEM. However, this study only focuses on the second part, where the developed model was assessed via quantitative measures using PLS-SEM analysis. The research method implemented in the study is further discussed in the Research Section.

As stated before, the study used the *context* model of Kofod-Petersen and Cassens (2006) as the basis for analysis. The model is illustrated in Figure 1. Kofod-Petersen and Cassens' (2006) *context* model describes *user context* from five aspects, which are: *environmental context, personal context, social context, task context,* and *spatio-temporal context*. The descriptions of the aspects are as the following (Kofod-Petersen and Cassens, 2006):

i. *Environmental context* covers the users' surroundings, such as things, services, people, and information accessed by the user;

ii. *Personal context* describes the mental and physical information about the user, such as mood, expertise and disabilities;

iii. *Social context* aspects explains the social aspects of the user, such as information about the different roles a user can assume;

iv. *Task context* explains what the user is doing, it can describe the user's goals, tasks and activities;

v. *Spatio-temporal context* consists of time, location and the community present.

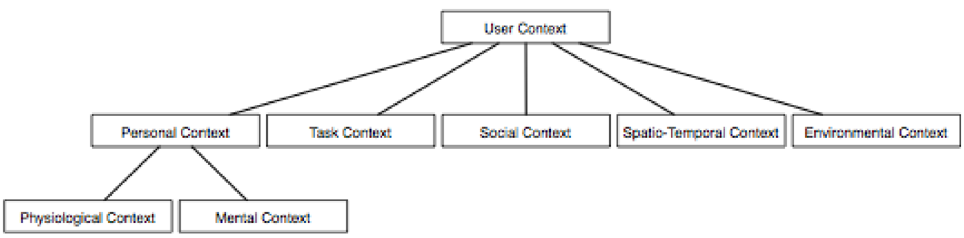


***Figure 1*: The context model by Kofod-Petersen and Cassens (2006)**

The Research Model

The research model tested in the study consists of six constructs and 44 respective indicators. The constructs are: (i) learning community awareness; (ii) learning space awareness; (iii) learning reflection awareness; (iv) social awareness; (v) task awareness; and (vi) personal awareness. Learning community awareness has six respective indicators, learning space awareness has seven, learning reflection awareness has eight, social awareness has seven, task awareness has six, and personal awareness has ten. The indicators are summarized in Table 1.

Table 1: The research model's constructs with their respective indicators

Construct	Indicator	Description
Learning community reflection	Peer activity status	Awareness of the past and current activity status of peers
	Peer activity changes	Awareness of the past and current changes of peers' activity
	Peer activity progress	Awareness of the past and current progress of peer activity
	Peer contribution	Awareness of peer contribution towards learning
	Peer approval	Awareness of the approval of learning task by peers
	Peer location	Awareness of location of peers before, during, and after learning
Learning space awareness	Information accessed	Awareness of information accessed via learning tools
	Learning tools	Awareness of the learning tools used during learning
	Location	Awareness of the location of learning
	Object in surroundings	Awareness of objects in the learning environment
	Proximity	Awareness of the nearness in relation to the learning site's location
	Services offered	Awareness of services offered during learning
	Weather	Awareness of weather at the learning location
Learning reflection awareness	Learning content reflection	Awareness of reflection on learning content provided to them via learning tools
	Learning outcome reflection	Awareness of reflection on learning outcomes during learning
	Learning progress reflection	Awareness of reflection on learning progress
	Own work reflection	Awareness of reflection on a student's own work
	Peer work reflection	Awareness of peer reflection on a student's work
	Own group reflection	Awareness of own group reflection on a students' work
	Non-group reflection	Awareness of non-group reflection on a students' work
	Facilitator reflection	Awareness of facilitator's reflection on a student's work
Social awareness	Role in groups	Awareness of the individual roles in teams according to the learning tasks
	Self-expectation	Awareness of self-expectation before, during or after learning
	Peer expectation	Awareness of peer's expectation before, during or after learning
	Peer interaction	Awareness of peer interaction during learning

Construct	Indicator	Description
	Peer feedback	Awareness of peer feedback during learning
	Facilitator expectation	Awareness of facilitator expectation before, during or after learning
	Facilitator interaction	Awareness of facilitator expectation before, during or after learning
	Facilitator feedback	Awareness of facilitator expectation before, during or after learning
Task awareness	Planning	Awareness of "plans related to learning tasks" made in the group
	Task distribution	Awareness of task distributed among group members
	Task goal	Awareness of the tasks' aim before conducting a particular task
	Task structure	Awareness of task structure/steps to complete a task
	Learning material	Awareness of learning material available to complete a task
	Time availability	Awareness of time available to complete a task
Personal awareness	Confidence	Awareness of self-confidence state during learning
	Effort	Awareness of efforts contributed during learning
	Motivation	Awareness of self-motivation state during learning
	Satisfaction	Awareness of self-satisfaction state during learning
	Self-improvement	Awareness of self-improvement state during learning
	Privacy	Awareness of privacy level during learning
	Anxiety	Awareness of anxiety state during learning
	Confusion	Awareness of confusion state during learning
	Diffidence	Awareness of diffidence state during learning

The constructs of the research model are derived based on the construct of the *context* model of Kofod-Petersen and Cassens (2006). The *context* model consisted of five constructs. Qualitative analysis was conducted via thematic analysis using the *context* model. As a result, six constructs seemed to emerge from the analysis. Three of the constructs (social awareness, task awareness, personal awareness) seemed to confirm with the constructs of the *context* model (social context, task context, personal context). Two other constructs seemed to be related to the environmental context and spatio-temporal context of the *context* model. However, the two constructs seemed to be better represented by the terms "learning space awareness" and "learning community awareness" respectively. Interestingly, one new theme seemed to emerge from the data. The theme is learning reflection awareness. Hence, the findings produced the research model consisting of six constructs and 44 respective indicators (see Figure 2).

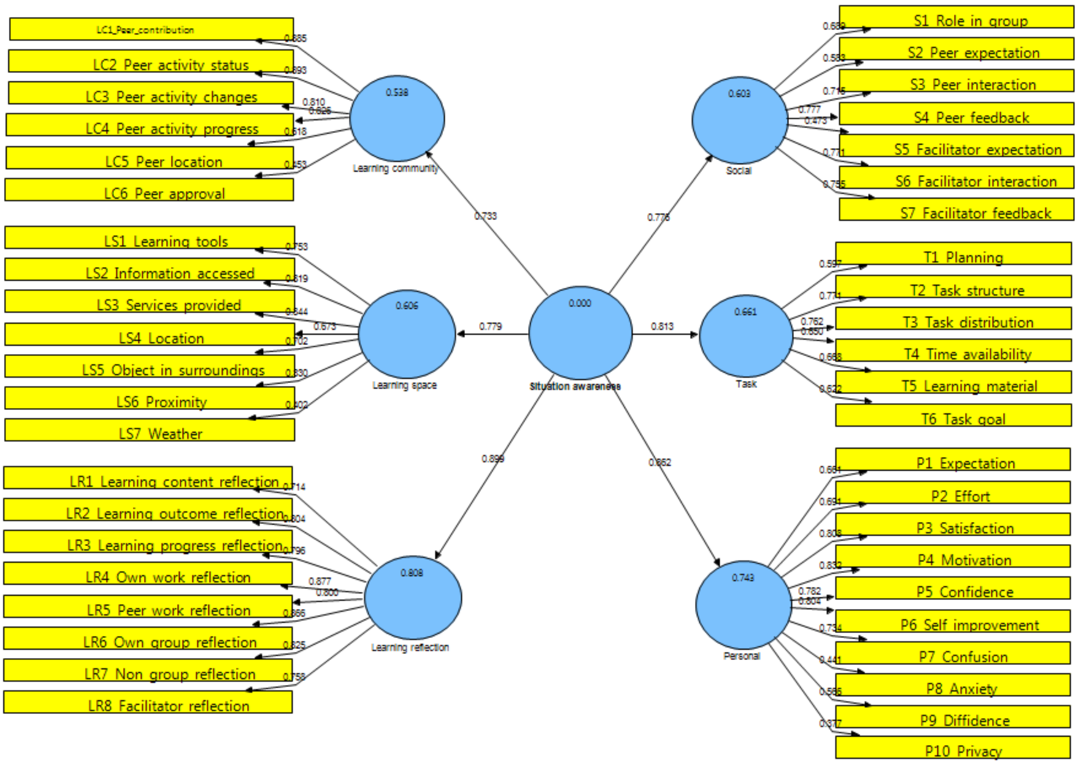


***Figure 2*: The research model before removal of indicators (first round of PLS-SEM analysis)**

Situation awareness and learning community awareness

Belkadi et al. (2012) posit that the concepts of a community are essential to assist team collaborators to anticipate each other's reactions in collaborative work. This can further be linked to the concept of "community of practice" and "situated learning", as the learner is involved in interacting with community members and participates in shared activity in a community (Aadal et al., 2013; Lave and Wenger, 1991). This in turn causes the learning community to develop a "shared knowledge bank" of learning experiences, stories, tools and methods of overcoming recurring learning problems as a result of members who have been a part of the community for a longer period (Wenger et al., 2009; Aadal et al., 2013). For the new learners, they exploit the community's "shared knowledge bank" with the aim of "mastering new understandings" (Lave and Wenger, 1991; Aadal et al., 2013). The learning community can further promote learner engagement in the learning community, and reach a sufficient level of understanding to participate in the learning practices, thus making learning more meaningful (Wenger et al., 2009). Thus, with respect to the research model, learner situation awareness is expected to be influenced by learning community awareness.

Situation awareness and learning space awareness

Janssen and Bodemer (2013) discovered that problems existing in the workspace or "learning space" are more obvious in online learning environments than in face-to-face environments as online learning environments offer less perceptual information. They explained that perceptual information refers to current status of group tasks, contribution of group members to the group process, behavioral and social activities, as well as skills and knowledge possessed by team members. The authors also stated that when students are unaware of their team members' status, this might accidently cause duplication of learning tasks and demotivate students. As a result, when students have learning space awareness, it can assist them in coordinating their actions, enhance their productivity, and reduce their chances of errors (Gutwin and Greenberg, 2004; Janssen and Bodemer, 2013). Kofod-Petersen and Cassens (2006) noted that the environment context influences context awareness in working environments. They found that the environment context is influenced by the elements in users' surroundings such as objects, services, people, and user accessed information. This can be somewhat mapped to learning space context as learners gain information from the surroundings in learning situations. Hence, in the research model, learner situation awareness is expected to be influenced by learning space awareness.

Situation awareness and learning reflection awareness

Yang (2010) developed a learning system to investigate learning reflection awareness – whether self-assessment and peer assessment influenced writing skills. The author discovered that peer assessment had a significant impact on enhancing writing skills. This can be somewhat related to learning reflection awareness because as students became aware of their mistakes as highlighted by their peers, it caused them to increase their self-awareness on improvements. In relation, Phielix et al. (2011) discovered that students learn by reflecting on peer feedback. By conducting reflections, students are engaged in cognitive and affective activities in reaching new understandings of their learning experiences. This can lead to learner situation awareness where learners become more aware of their own actions and behavior, how it affects their peers, and whether they should change their action and behaviors to achieve their individual and group learning goals. Thus, in the research model, learner situation awareness is expected to be influenced by learning reflection awareness.

Situation awareness and social awareness

A key element in successful collaborative learning is the element of social interaction that includes cognitive processes (i.e., task-related processes) such as discussion, reasoning, reflection, and critical thinking, as well as social processes (i.e., non-task related processes) such as cohesiveness and trust (Kreijns et al., 2003; Phielix et al., 2011). These processes enable group members to know and understand each other in collaboratively performing tasks, solving problems or constructing new knowledge (Gunawardena, 1995; Jonassen, 2000; Kreijn et al., 2003; Phielix et al., 2011). This can be related to the concept of "role in groups" within collaborative teams as suggested by Belkadi et al. (2012), where they emphasized that this concept is useful in understanding relationships within collaborative teams. They also explained the "role" concept as suggested by several authors (Detienne, 2006; Garrido et al., 2007; Van der Aalst and Kumar, 2001), in which the emphasis was on factors relating to an individual's characteristic and appropriate time in implementing the concept. The authors stated that the "role in groups" concept depends on the abilities, expertise, and skills of collaborators in a team. For successful collaborative tasks, it is essential that the "team leader" recognizes the team members' abilities, expertise, and skills and maps them appropriately with roles the individual can perform. Hence, the research model suggests that learner situation awareness is expected to be influenced by social awareness.

Situation awareness and task awareness

Covertino et al. (2004) described task awareness as collaborators' ability to understand the "overall picture" on ongoing team tasks/activities as well as other teams' tasks in the projects. Meanwhile, Borges et al. (2005) modeled situation and awareness in teamwork. The authors emphasized that task awareness is affected by relationships between team members and interactions among them. They also suggested that the environment as well as scheduled and completed tasks impact task awareness. Detienne (2006) claimed that action awareness is closely related to task awareness; the concept of "action awareness" is related with the state of team members' contribution and task-oriented artifacts with awareness of task members' understanding and plans. Belkadi et al. (2012) however argue that the relationship proposed by Detienne (2006) is valuable but it is hardly applicable as the concepts of situation and action are closely related to one another, because an action of a team member would have significant effects on other team members. They also believed that each collaborator in a group interacts with other collaborators or resources in order to achieve task aims. As such, Belkadi et al. (2012) concluded that situation awareness is related to task awareness since a collaborator's situation awareness depends on making decisions in collaborative situations based on what other collaborators are effectively doing. They also emphasized that a lack of situation awareness is likely to lead to negative group level impacts. Therefore, in the research model, learner situation awareness is expected to be influenced by task awareness.

Situation awareness and personal awareness

The Kofod-Petersen and Cassens (2006) study used the activity theory in modeling "contexts" or "situations" of artificial or real agents in a pervasive computing environment. They claimed that one of the factors influencing "context" is the personal aspect. This is related to the mental and physical information about the user. Hence, in the research model, learner situation awareness is expected to be influenced by personal awareness.

Research hypotheses

From the previous discussions, the following research hypotheses are proposed:

Hypothesis 1: Learner situation awareness is reflected by learning community awareness.

Hypothesis 2: Learner situation awareness is reflected by learning space awareness.

Hypothesis 3: Learner situation awareness is reflected by learning reflection awareness.

Hypothesis 4: Learner situation awareness is reflected by social awareness.

Hypothesis 5: Learner situation awareness is reflected by task awareness.

Hypothesis 6: Learner situation awareness is reflected by personal awareness.

Research method

Respondent background

The respondents were 71 novice teacher trainees (10 male, 61 female) taking an educational technology course in a local university. The teacher trainees had limited background in technology usage for teaching. The average age of the respondents was 22 years. They had limited or negligible experience in using video technology for instructional purposes. The educational technology course was carried out in a blended learning environment integrating both face-to-face mode for course lectures as well as mobile Web 2.0 learning mode. The course aim was to develop the trainees' technology usage skills, particularly video production and social media use (i.e., Facebook, blog, and mobile augmented reality), for future teaching purposes.

Data collection procedure

The study was conducted over four months in an educational technology course. The course was carried out via a video production module integrated into the course. It was conducted in blended learning mode. In each module session, 30-minute face-to-face lectures were given. The learning activities were conducted after the lectures, in one-and-half hour sessions. The instruction was conducted as the following: (i) students were divided into groups of five or six students; (ii) each group produced a 5-minute video on an open topic collaboratively; (iii) students were encouraged to discuss their learning activities collaboratively with group members in the mobile Web 2.0 learning environment; (iv) students were encouraged to conduct reflections of learning cooperatively in the learning environment; and (v) students were provided with mobile augmented reality to assist them in locating learning sites.

A mobile Web 2.0 learning environment was developed and provided to the students to: (i) facilitate online discussions among them inside and outside the classroom; and (ii) provide them with additional online learning material (e.g., course moblog on video production methods). The students were also encouraged to discuss their work in "open" and "closed" groups on the social media platform (explained further in a later section) in line with Aydin (2012), where a social platform can be implemented as an educational environment. "Open" groups refer to groups in which the discussions are open to the public or to a larger group of people, whereas "closed" groups refer to a smaller group where discussions are "closed" within the group. In addition, the students were assigned to produce "individual" and "group" moblogs to reflect on their learning. Mobile augmented reality technology was also provided to assist students in retrieving location-based information for their tasks (i.e., search for learning sites to assist in task completion). The technology helped them in terms of augmented information (e.g., history of building or location), exact position of point-of-interest (e.g., GPS coordinates of interesting place), as well as additional information of location (e.g., pictures taken by users who have been to location before them).

Data analysis procedure

Data procedure for identification of research model's constructs and indicators

This study is a part of a larger study aimed at modelling learner situation awareness in collaborative mobile Web 2.0 learning. In the larger study, the data analysis conducted is a qualitative analysis via thematic analysis, video interviews and inter-rater reliability analysis. A mobile Web 2.0 learning environment, called Mobi2Learn, was designed iteratively with expert consensus using the participatory design approach. Using thematic analysis (Braun and Clarke, 2006), the themes and sub-themes that seemed to be related to learner situation awareness were coded from social networking sites and moblog transcripts. The coding was conducted using NVivo version 8.0. Data triangulation was then conducted via video interviews with 21 participants to gain more information about the coded themes. The themes and sub-themes coded were then analyzed via inter-rater reliability analysis using two inter-raters to ensure the sub-themes were representative of each theme.

Data procedure for investigation of research model reliability, validity and relationships between constructs and indicators

The main aim of this study is to investigate the validity and reliability of the research model (identified in the larger study) as well as verify the relationships between the new constructs and their respective indicators. As such, an online questionnaire was distributed to 71 students who have completed the educational technology course. The questionnaire consisted of questions that required pre-determined responses. The measurement scale used was a five-point integer scale. This was because interval-level scales have equidistant intervals – in other words, the scale consists of the rank of a particular score and provides measures indicating how much greater or less a score is compared to another (Treiblmaier and Filzmoser, 2011). The questionnaire design was based on the research model. The questionnaire was then run through the content validation procedure to increase its validity. Two educational technology lecturers, two IT experts, and a language lecturer conducted validation on pedagogical, technological, language and measurement aspects of the questionnaire to confirm the questions for each variable were clear and concise. As a result, the questionnaire consisted of 56 items as measurements. The questionnaire was designed based on Belkadi et al. (2012), Cochrane (2013), Yang (2010), and Kofod and Petersen's (2006) research.

PLS-SEM was used to analyze the responses to the online questionnaire. PLS-SEM was chosen for data analysis because it can be used to develop theories or models in exploratory research (Hair et al., 2014). Moreover, Hair et al. (2014) adds that it is recommended to use PLS-SEM when the main aim of the research is to conduct predictions and explanations of target constructs. In relation, Chin (1998) explains that PLS-SEM is capable of predicting the formations of individual constructs (i.e., indicators related to each individual construct) and identifies relationships among the constructs (Chin, 1998). In other words, PLS-SEM can verify that the research model is valid and reliable as well as explore the relationships in a structural model. In terms of sample size and model complexity, PLS-SEM is capable of handling small sample sizes and complex models as the technique does not make any assumptions about the underlying data (Hair et al., 2014; Lee et al., 2007).

The PLS-SEM analysis consisted of two types of analysis, which were measurement model analysis and structural model analysis. The measurement model analysis consisted of three tests: (i) internal consistency reliability; (ii) convergent validity; and (iii) discriminant validity. The structural model analysis consisted of two tests: (i) structural model path coefficients; and (ii) coefficient of determination, R^2 values. These analyses were conducted in two PLS-SEM analysis rounds. The results are discussed in the Results section.

Mobi2Learn: The mobile web 2.0 learning environment

In order to assess mobile Web 2.0 learning, a mobile Web 2.0 learning environment, called Mobi2Learn was developed, as illustrated in Figure 3.

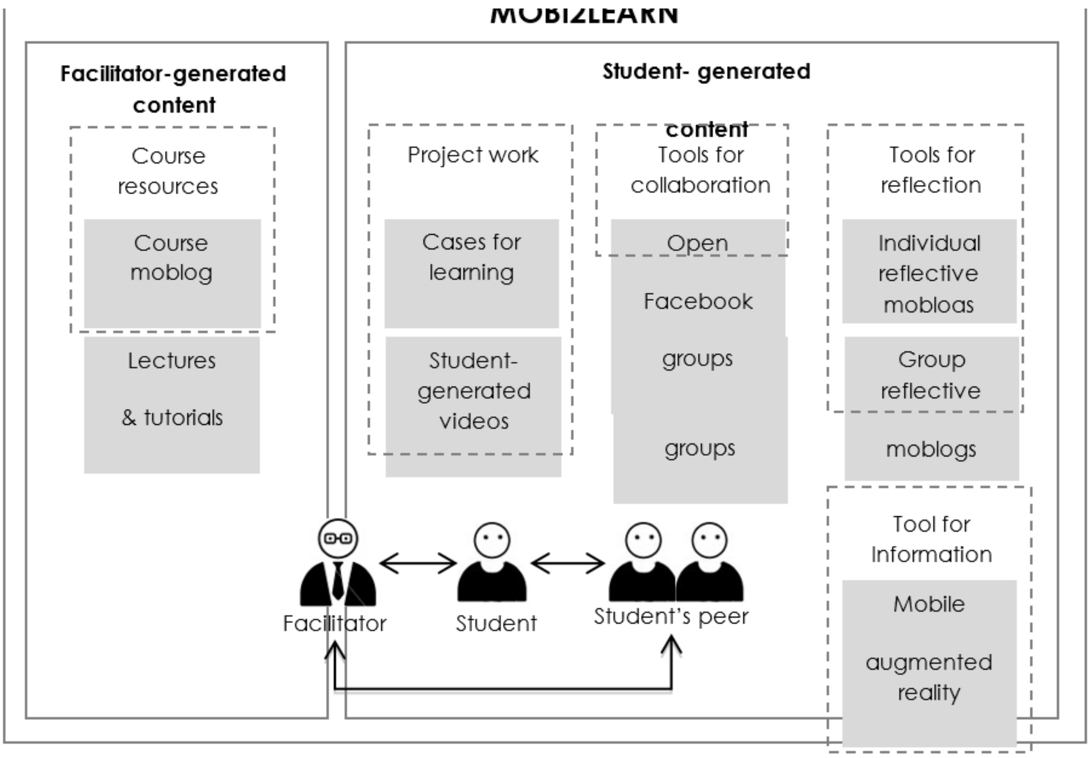


Figure 3. **The mobile Web 2.0 learning environment called Mobi2Learn**

The Mobi2Learn environment consists of two main components for teaching and learning content production, which are: the platform for facilitator-generated content, and the platform for student-generated content.

Platform for facilitator-generated content

The platform consists of the course moblog, as well as lectures and tutorials. The course moblog was developed as a guide for students to produce their video. Lectures and tutorials slides were provided to the students in the course moblog (for review on moblogs, refer to Norman et al., 2014).

Platform for student-generated content

The platform consists of the project work, tools for collaboration, tools for reflection, and tool for information retrieval.

Project work

Project work contained *cases for learning* and student-generated videos. As discussed before, *cases for learning* were the aim of the group task and student-generated videos were the products that students had to produce to reach the aim of the tasks.

Tools for collaboration

Students were provided with open and closed Facebook Groups to collaborate and conduct discussions among them. In open Facebook Groups, the communications among students and instructors are "public" to the whole class but restricted to access from the outside community. In closed Facebook Groups, groups are created based on students' grouping (teams) according to the course project. This medium allows for more "private" discussions between team members as ideas and comments are shared within the team nucleus only.

Tools for reflection

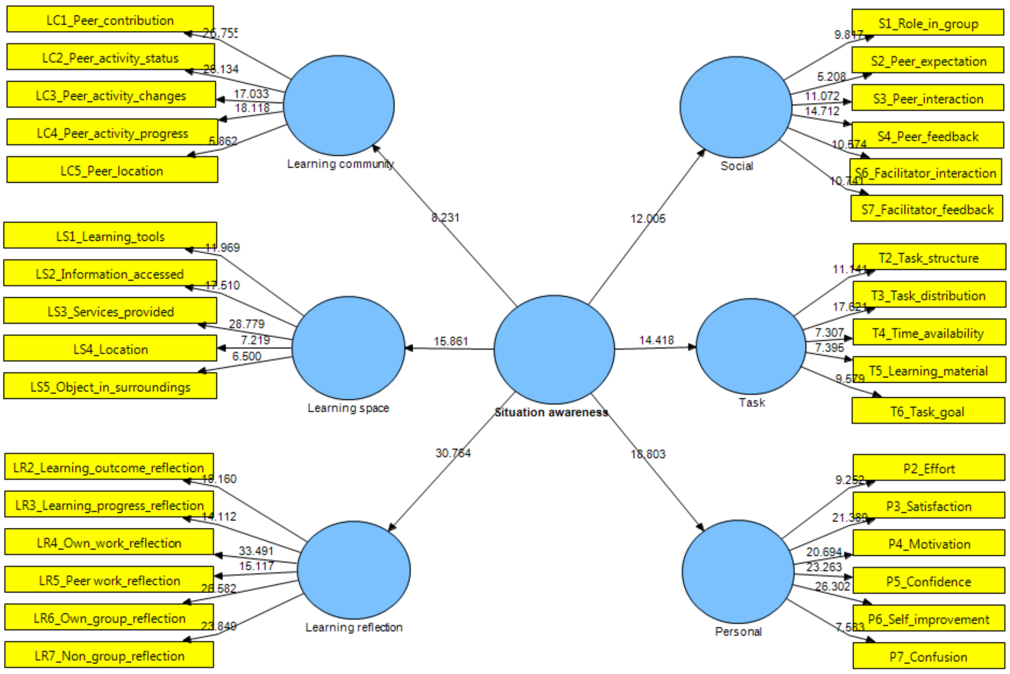
Students were also provided with moblog technology. Individual reflection moblogs allowed students to maintain records of their individual reflections on learning experiences, acquired skills, learning progress, and views on the learning module. Group reflection moblogs allowed student groups to create reflections of their own group.

Tools for information retrieval

Students were provided with mobile augmented reality technology to assist them in accessing location-based information.

RESULTS

The PLS-SEM analysis was conducted in two rounds. In the first round, the findings indicated inadequate results for the measurement model analysis tests, illustrated in Figure 4. As a result, 11 indicators were dropped because of inadequacies in internal consistency reliability, convergent validity, and discriminant validity. The indicators are: *peer approval, proximity, weather, learning content reflection, facilitator reflection, facilitator expectation, planning, expectation, anxiety, diffidence,* and *privacy.*



The second round of PLS-SEM produced the revised learner situation awareness model for mobile Web 2.0 learning. The revised research model consisted of six constructs and 33 respective indicators. The results of the second round of PLS-SEM data analysis are explained according to: the reflective measurement model analysis, and the structural model analysis.

Reflective measurement model analysis: Internal consistency reliability

The study conducted the reflective measurement model analysis for assessing the reliability and validity using three tests, which are: (i) internal consistency reliability; (ii) convergent validity; and (iii) discriminant validity. The results of the tests are discussed in the following paragraphs.

Internal consistency reliability was conducted to assess the consistency of the instruments' measures towards the learner situation awareness constructs (Hair et al., 2014; Sekaran and Bougie, 2010). The analysis involved investigation of composite reliability (CR) values. The cut-off value for CR is 0.7, where 0.7 is considered acceptable by Fornell and Larcker (1981). The results of the internal consistency reliability test are summarized in Table 2. From the table, it can be seen that all alpha values are approximately .8 as suggested by Nunnally and Berstein (1994). The composite reliability values also ranged from .837 to .934, which suggest acceptability. From these results, we can conclude that the constructs of the learner situation awareness model are reliable.

Table 2: Internal consistency reliability

Construct	AVE	CR	R^2	Cronbach's alpha
Learning community	0.678	0.912	0.500	.877
Learning reflection	0.703	0.934	0.779	.915
Learning space	0.593	0.878	0.596	.826
Personal	0.652	0.918	0.662	.892
Social	0.526	0.868	0.594	.814
Task	0.508	0.837	0.619	.760

Reflective measurement model analysis: Convergent validity

Convergent validity analysis was conducted to assess (Hair et al., 2014): "the extent to which a measure correlates positively with alternate measures of the same construct." It was assessed via: (i) assessment of factor loadings, (ii) composite reliability (CR); and (iii) average variance extracted (AVE) (Hair et al. 2014).

First, loadings were checked to identify whether there were problems with any particular items (Hair et al., 2014; Ramayah et al., 2011). Table 3 shows the results of the loadings of the indicators related to their respective constructs (LC for learning community, LR for learning reflection, LS for learning space, P for personal, S for social, and T for task awareness). All loadings exceeded the cut-off values of 0.5 signifying that the indicators are related to their respective constructs.

Next, the CR and AVE value were accessed. The cut-off values for CR were 0.7 and above (Hair et al., 2014), and values exceeding 0.5 for AVE (Barclay et al., 1995). In Table 3, all the items for CR exceeded the recommended value of 0.7. The AVE for all the constructs was above the recommended value of 0.5, where Barclay et al. (1995) recommended that AVE values be larger than 0.50 to justify using a construct. Thus, the results confirm convergent validity.

Table 3: Convergent validity

Construct	Indicator	Loading	AVE	CR
Learning community	LC1_Peer_contribution	0.892	0.678	0.912
	LC2_Peer_activity_status	0.884		
	LC3_Peer_activity_changes	0.830		
	LC4_Peer_activity_progress	0.860		
	LC5_Peer_location	0.620		
Learning reflection	LR2_Learning_outcome	0.811	0.703	0.934
	LR3_Learning_progression	0.794		
	LR4_Self_reflection	0.891		
	LR5_Self_assessment	0.832		
	LR6_Peer_reflection	0.873		
	LR7_Peer_assessment	0.827		
Learning space	LS1_Learning_tools	0.779	0.593	0.878
	LS2_Information_accessed	0.825		
	LS3_Services_provided	0.879		
	LS4_Location	0.680		
	LS5_Object_in_surroundings	0.665		
Personal	P2_Effort	0.745	0.652	0.918

Construct	Indicator	Loading	AVE	CR
	P3_Satisfaction	0.838		
	P4_Motivation	0.861		
	P5_Confidence	0.839		
	P6_Self_improvement	0.849		
	P7_Confusion	0.699		
Social	S1_Role_in_group	0.711	0.526	0.868
	S2_Peer_expectation	0.532		
	S3_Peer_interaction	0.748		
	S4_Peer_feedback	0.803		
	S6_Facilitator_interaction	0.762		
	S7_Facilitator_feedback	0.764		
Task	T2_Task_structure	0.746	0.508	0.837
	T3_Task_distribution	0.771		
	T4_Time_availability	0.673		
	T5_Learning_material	0.694		
	T6_Task_goal	0.674		

Reflective measurement model analysis: Discriminant validity

The discriminant validity analysis was aimed at indicating that constructs of the model are unique and captured the phenomenon that is not captured by other constructs (Hair et al., 2014). As such, two tests were implemented: (i) cross loading assessment; and (ii) Fornell-Larcker criterion. In the cross loadings assessment, loadings of constructs' indicators should load more strongly/higher on their own constructs rather loadings on other constructs (Hair et al., 2014). In the Fornell-Larcker criterion, the square root of AVE value is compared with the latent variable correlations. This shows that a construct shares more variance with its own indicators as compared to any other construct (Hair et al., 2014).

First, cross loadings were checked to identify whether there were problems with any particular items (Hair et al., 2014; Ramayah et al., 2011). Table 4 shows the results of the loadings of the items related to their respective constructs (LC for learning community, LR for learning reflection, LS for learning space, P for personal, S for social, and T for task awareness).

Table 4: Discriminant validity (loadings and cross loadings)

Indicator	Learning community	Learning reflection	Learning space	Personal	Social	Task
LC1_Peer_contribution	0.892	0.510	0.394	0.399	0.626	0.464
LC2_Peer_activity_status	0.884	0.423	0.379	0.400	0.580	0.487
LC3_Peer_activity_changes	0.830	0.372	0.383	0.319	0.594	0.401
LC4_Peer_activity_progress	0.860	0.402	0.357	0.327	0.585	0.408
LC5_Peer_location	0.620	0.260	0.363	0.187	0.434	0.439
LR2_Learning_outcome	0.323	0.811	0.518	0.630	0.445	0.574
LR3_Learning_progression	0.426	0.794	0.460	0.637	0.437	0.434
LR4_Self_reflection	0.343	0.891	0.495	0.675	0.515	0.498
LR5_Self_assessment	0.345	0.832	0.558	0.606	0.428	0.379
LR6_Peer_reflection	0.445	0.873	0.465	0.586	0.500	0.558
LR7_Peer_assessment	0.546	0.827	0.527	0.596	0.586	0.638
LS1_Learning_tools	0.503	0.565	0.779	0.534	0.484	0.482
LS2_Information_accessed	0.427	0.440	0.825	0.496	0.343	0.483

LS3_Services_provided	0.406	0.487	0.879	0.542	0.403	0.538
LS4_Location	0.187	0.406	0.680	0.333	0.253	0.541
LS5_Object_in_surroundings	0.138	0.392	0.665	0.413	0.314	0.336
P2_Effort	0.269	0.448	0.428	0.745	0.298	0.374
P3_Satisfaction	0.391	0.630	0.515	0.838	0.368	0.459
P4_Motivation	0.289	0.654	0.508	0.861	0.377	0.447
P5_Confidence	0.313	0.635	0.454	0.839	0.328	0.465
P6_Self_improvement	0.372	0.697	0.455	0.849	0.461	0.531
P7_Confusion	0.315	0.491	0.602	0.699	0.423	0.340
S1_Role_in_group	0.505	0.428	0.411	0.401	0.711	0.424
S2_Peer_expectation	0.301	0.485	0.174	0.447	0.532	0.375
S3_Peer_interaction	0.523	0.431	0.384	0.264	0.748	0.472
S4_Peer_feedback	0.543	0.434	0.335	0.277	0.803	0.385
S6_Facilitator_interaction	0.460	0.384	0.373	0.333	0.762	0.430
S7_Facilitator_feedback	0.636	0.376	0.368	0.322	0.764	0.372
T2_Task_structure	0.550	0.392	0.454	0.346	0.486	0.746
T3_Task_distribution	0.570	0.507	0.506	0.380	0.542	0.771
T4_Time_availability	0.184	0.438	0.303	0.284	0.333	0.673
T5_Learning_material	0.098	0.389	0.494	0.403	0.110	0.694
T6_Task_goal	0.371	0.461	0.433	0.515	0.455	0.674

Cut-off values of 0.5 for cross loadings are considered significant (Chin, 1998). From Table 4, all of the items measuring a particular construct loaded highly on their respective constructs (values in bold color) and loaded lower on other constructs. Thus, the findings indicate that the model confirmed discriminant validity.

Next, we proceed with the Fornell-Larcker criterion assessment. The test is conducted by assessment of correlations between measures of potentially overlapping constructs (Hair et al., 2014; Ramayah et al., 2011). In the tested model, items should load more strongly on their own constructs. The values of average variance shared between each construct and its measures should also be larger than the variance between the construct and other constructs (Compeau et al., 1999). As such, the discriminant validity was assessed for each construct of the model. Table 5 indicates that the squared correlations for each construct are less than the AVE by the indicators measuring that construct thus confirming adequate discriminant validity.

Table 5: Discriminant validity (Fornell-Larcker criterion)

Construct	**Learning community**	**Learning reflection**	**Learning space**	**Personal**	**Social**	**Task**
Learning community	0.824					
Learning reflection	0.486	0.839				
Learning space	0.454	0.601	0.770			
Personal	0.405	0.741	0.611	0.807		
Social	0.689	0.582	0.476	0.468	0.725	
Task	0.533	0.617	0.619	0.544	0.566	0.713

Structural model analysis: Structural model path coefficients

The structural model path coefficients test (or hypotheses tests) was conducted to examine the hypothesized relationships among the constructs. The significance of the path coefficients was assessed via bootstrapping where the bootstrapping standard error allows for the empirical *t* value to be calculated (Hair et al., 2014). The criterion is that if the empirical *t* value is larger than the critical value, the coefficient is considered "significant" at a certain error probability level or significance level (Hair et al., 2014). The common critical values for two-tailed tests are 1.65 (significance level = 10%), 1.96 (significance level = 5%), and 2.57 (significance level = 1%). In this test, six research hypotheses (i.e., relationship between low-order models and higher order models) were assessed via assessment of their empirical *t* value against the critical values for two-tailed tests.

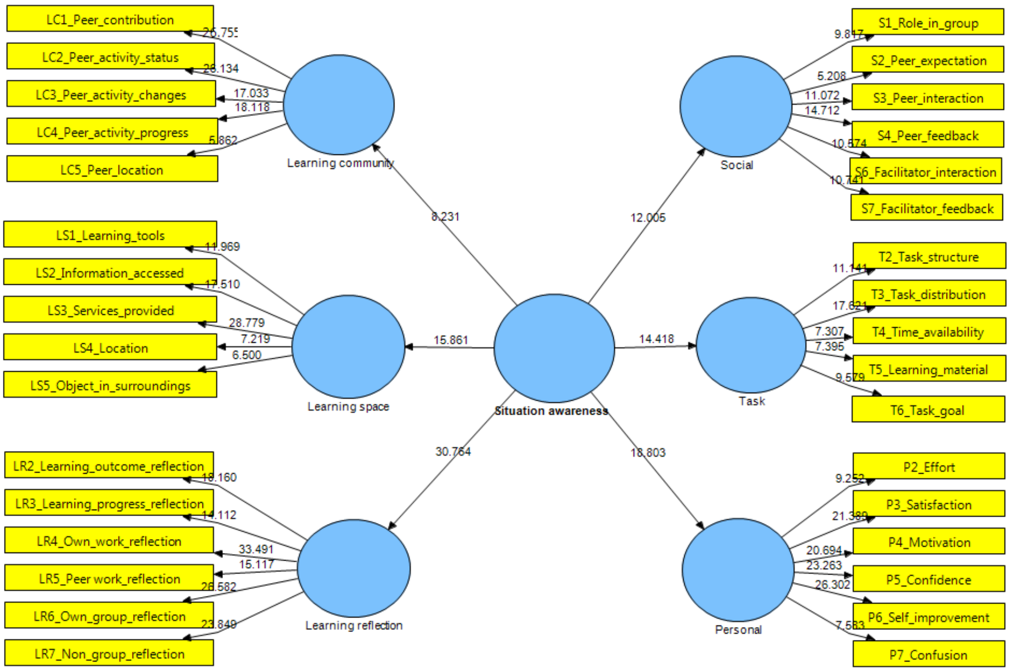


***Figure 4.* The revised research model after removal of indicators (PLS-SEM second round – results of structural model path coefficient)**

Table 6: Structural model path coefficients (hypotheses testing)

Hypothesis	R^2	Beta	Standard Error	*t*- value	Decision
Situation awareness -> Learning community	0.500	0.707	0.079	8.960*	Supported
Situation awareness -> Learning reflection	0.779	0.883	0.030	29.507*	Supported
Situation awareness -> Learning space	0.596	0.772	0.048	16.209*	Supported
Situation awareness -> Personal	0.662	0.814	0.044	18.699*	Supported
Situation awareness -> Social	0.594	0.771	0.059	13.103*	Supported
Situation awareness -> Task	0.619	0.787	0.049	15.988*	Supported

**$p < .01$, * $p < .05$

The results of the structural model path coefficient test are shown in Figure 4 and Table 6. Based on Table 6, all the *t* values exceeded the critical values of 2.57 (Hair et al., 2014) indicating that learner situation awareness in collaborative mobile Web 2.0 learning is significantly reflected by six constructs which are learning community awareness, learning space awareness, learning reflection awareness, personal awareness, social awareness, and task awareness. Thus, the findings supported all six hypotheses.

Structural model analysis: Coefficient of determination, R^2

The second structural model analysis is the R^2 (coefficient of determination) values of the structural model were. Higher values indicate that the observed values were substantially replicated by the model, while lower values indicate that the observed values were weakly replicated by the model (Hair et al., 2014). The rules of thumb for R^2 values suggested by Hair et al. (2014) are: (i) $R^2 \approx 0.75$ is considered "substantial"; (ii) $R^2 \approx 0.50$ is considered "moderate"; and (iii) $R^2 \approx 0.25$ is considered "weak."

Referring to R^2 values in Figure 5, the following can be concluded: (a) learning community awareness is reflected by ~50% of the total variance of learner situation awareness; (b) learning space awareness is reflected by ~60% of the total variance of learner situation awareness; (c) learning reflection awareness is reflected ~78% of the total variance of learner situation awareness; (d) personal awareness is reflected by ~67% of the total variance of learner situation awareness; (e) task awareness is reflected by ~62% of the total variance of learner situation awareness; and (f) social awareness is reflected by more than 60% of the total variance of learner situation awareness for collaborative mobile Web 2.0 learning.

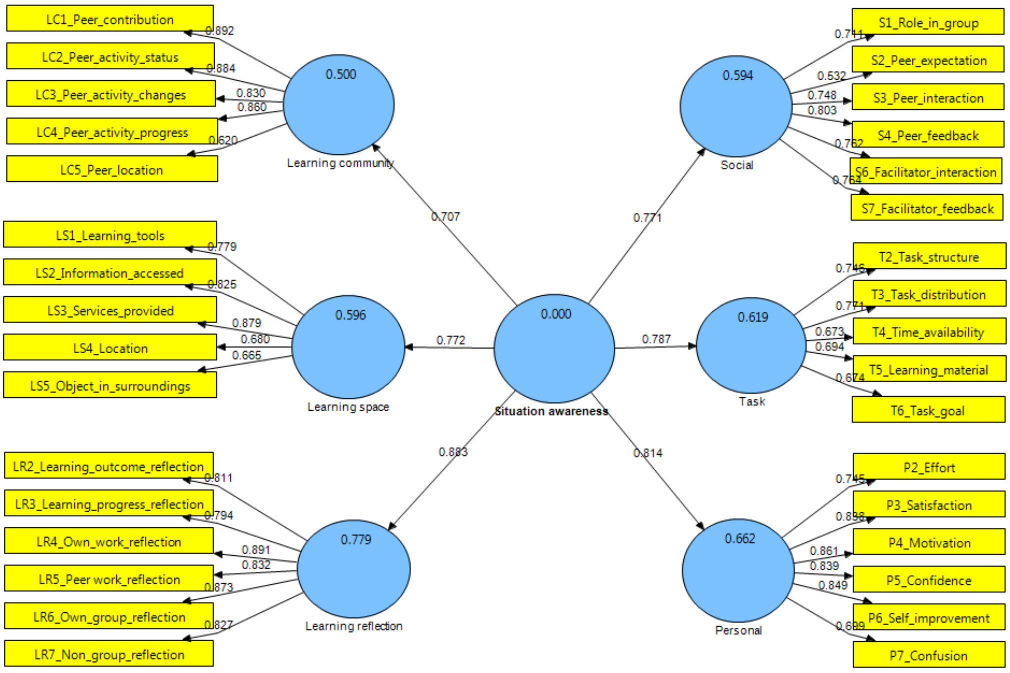


***Figure 5.* The results of coefficient of determination (R^2) test.**

As such, two constructs, which are learning reflection awareness and personal awareness, were "substantially" replicated by the model. The other remaining constructs, task awareness, learning space awareness, learning community awareness, and social awareness were "moderately" replicated by the model. In sum, as the research model explained more than 60% of the total variance in learner situation awareness, the research model has a good predictability and explanatory power for learner situation awareness in collaborative mobile Web 2.0 learning.

DISCUSSION

Reflective measurement model analysis

The results of the reflective measurement model analysis via three tests (internal consistency reliability, convergent validity, discriminant validity) confirm that the refined research model is valid and reliable. The results also indicated that there are 33 indicators that reflect the six constructs of the refined research model as compared to the original 44 indicators. The indicators suggested for removal are: (i) *peer approval* from learning community awareness; (ii) *proximity* and *weather* from learning space awareness; (iii) *learning content reflection* and *facilitator reflection* from learning reflection awareness; (iv) *facilitator expectation* from social awareness; (v) *planning* from task awareness; and (vi) *expectation, anxiety, diffidence,* and *privacy* from personal awareness. However, we argue that these indicators could still be useful in studying learner situation awareness in collaborative mobile Web 2.0 learning. The following discusses the rationale for their inclusion.

It was recommended that *peer approval* be removed from learning community awareness. We deemed this to be an important factor due to the fact that students in social networking *Groups* were observed to seek *peer approval* of their work and contribution towards the group. It seemed that as students gained *peer approval* from their team members, they felt a sense of inclusion towards the team, in this case, the small-sized learning community. This further contributes to the fact that before students make decisions to proceed in conducting/finishing a learning task, they would seek *peer approval* in order to gain a team consensus/perception of their work. This can be linked to findings by Dabbagh and Kistantas (2012) indicating that peer feedback is an important aspect for personalized formal and informal learning .

For learning space awareness, *Proximity* and *weather* were recommended to be removed. However, both of the sub-themes are important for inclusion in the research model because information on *proximity* and *weather* assisted students to be aware of the situation of the learning space. In fact, awareness of these indicators helped them to make decisions on whether or not to visit the location sites suggesting that *proximity* and *weather* play important roles in the decision-making process in collaborative mobile Web 2.0 learning. This corroborates with the work of Kiani et al. (2013), where they reported that proximity is an important factor in cross-team collaborations.

Learning content reflection and *facilitator reflection* were suggested to be removed from learning reflection awareness. We also argue that both of these indicators are important. The rationale for their inclusion can be linked to state of reflection-in-action and refection-on-action reported in the work of Yang (2010). With regard to reflection-on-action, students reflected on *learning content* and *facilitator reflection* after completing their learning tasks. Reflection on the *learning content* and *facilitator reflection* coincidentally contributed to the awareness of their *learning progress.* These reflections-on-action further contributed to the future reflections-in-action. As students proceeded to a future learning task, the reflections-on-action of *learning content* and *facilitator reflection* gained before, coincidentally assisted the students in being more informed (by previous learning reflections) about making new decisions in the learning tasks (Yang, 2010).

For social awareness, the *facilitator expectation* indicator was recommended to be removed from the research model. Again, we emphasize the rationale behind the importance of including this indicator. In virtual and physical spaces, we observed that students made decisions based on what facilitators expected of them (e.g., produce learning products). It seemed that *facilitator expectation* made students become aware of their learning goals and further helped them in making decisions in learning; this can be linked to Oncu and Cakir's (2011) work where they studied peer response with regard to learner expectation.

For task awareness, *planning* was suggested to be removed. To better visualize the importance of this indicator, we illustrate the scenario with the following example. It was noticed that students during learning tasks seemed to *plan* their learning activities according to the *time available* to them. When they became aware of the *plans* of the team members and *time available* for them to complete the tasks, it seemed that the students gained a "collaborative mutual understanding" of what they had to perform in order to complete their learning tasks, thus influencing their decision-making. This is corroborated by Janssen et al. (2012) indicating that the aspects of planning and monitoring are important in collaborative online learning.

For personal awareness, four indicators were recommended to be dropped. Here, we can see that the four indicators were negative personal aspects (*confusion, anxiety, diffidence, privacy*). The indicators could be useful for investigating personal awareness (refer to Liaw and Huang (2013) for negative emotional conditions such as peceived anxiety). Patterns of *confusion, anxiety* and *diffidence* were observed when students faced problems in conducting learning tasks. As they exhibited patterns of *confusion, anxiety* and *diffidence,* it seemed that the students became more aware that they were incapable of finishing a learning task. For example, when a student was *confused,* it seemed to have led to increased levels of *anxiety* and *diffidence* further leading to poor decision making. This might have even caused students to express concern for *privacy,* which was noticed as students used private messages to communicate among themselves.

Structural model analysis

The results revealed that all the research hypotheses were supported. This indicates that learner situation awareness in collaborative mobile Web 2.0 learning is reflected by six constructs. The constructs are learning community awareness, learning space awareness, learning reflection awareness, social awareness, task awareness, and personal awareness.

Furthermore, the R^2 values showed that learner situation awareness is "substantially" reflected by learning reflection awareness because it represented ~78% of the total variance. This infers that learning reflection awareness could be an essential factor in understanding learner situation awareness in collaborative mobile Web 2.0 learning. The results can be related to the findings of Phielix et al. (2011) suggesting that peer reflection could enhance learning in a CSCL environment. This implies that peer reflection could be used to increase learner situation awareness as learners become aware of their own learning as well as their peer's learning resulting in gaining of new understandings. Moreover, these results also can also be related to Yang's (2010) findings indicating that self-assessment and peer assessment could be utilized by educators in promoting students to be more aware of mistakes and encouraging them to increase their awareness on self-improvement.

The R^2 values also showed that personal awareness is "substantially" replicated in the model (~67%). This indicates that personal awareness is also an important factor in understanding learner situation awareness in collaborative mobile Web 2.0 learning. An interesting perspective on personal context can be viewed from Chang et al.'s (2012) study on English mobile learning systems. They investigated the students' acceptance of mobile learning system by assessing relationships between perceived ease of use, playfulness, usefulness, convenience, and continuance intention. They discovered that most of the relationships have positive correlations with one another, with the exception of the perceived convenience-continuance intention relationship. It is worth noting that these elements could also be considered when conducting investigation on the personal context as they could influence learner mental state.

The results also indicated that four constructs "moderately" reflected learner situation awareness in collaborative mobile Web 2.0 learning. The constructs are task awareness (~62% of the total variance of learner situation awareness), learning space awareness (~60%), social awareness (~60%), and learning community awareness (~50%). These results can be linked to studies by Belkadi et al. (2012), Janssen and Bodemer (2013) and Schuck et al. (2013).

For task awareness, it may be concluded that learners in a group are likely to make a decision based on the tasks given to them. The scenario is evident in this study in reflections of students in moblogs. Reflections in moblogs seemed to assist students in knowing in-depth which tasks their team members were doing, which tasks they have done, and which tasks that they are going to do. As a result, students increased their task awareness that in turn seem to aid them in coordinating their workflow in which tasks were carried out in two modes: cooperative, and collaborative mode in line with the ideas of Ryberg et al. (2010). In cooperative mode, students conducted their tasks individually and then cooperatively discussed the output with team members. In collaborative mode, they performed group tasks collaboratively at the same time. As both modes assisted teams in conducting collaborative tasks successfully, it would be interesting for educators to investigate which mode is appropriate across learning contexts.

For social awareness, interactions between peers and facilitators are important in understanding a learning situation before making a decision. Nevertheless, although the results suggest that these factors are important, studies have reported that social technology (i.e., implemented in mobile Web 2.0 learning) could have negative effects on learning if not implemented with care (Kreijns et al., 2003; Schuck et al., 2013). Kreijns et al. (2003) stated that although social technology is designed to promote interaction among users, there are instances where technology can disrupt learning. This happens when educators “consciously” or “unconsciously” take social interaction “for granted” in learning – by perceiving that social technology can promote learning on its own (Kreijns et al., 2003). To ensure that meaningful learning is promoted, social interaction should be intentionally designed for learning (Kreijn et al., 2003; Schuck et al., 2013).

For learning space awareness, it can be inferred that not only do knowledge and behavior aspects impact learning space awareness, the virtual and physical information that exist in the learning space (e.g., images from the surroundings during a learning activity or information that can be accessed via the Internet) may affect learner situation awareness too. Similar to task awareness, learning space awareness could assist students in coordinating their activities, and reduce chances of errors. Janssen and Bodemer (2013) discovered that increasing students’ awareness in the learning space could reduce duplication of learning tasks conducted by group members, thus avoiding demotivation.

The final remaining construct – learning community awareness – has the least variance among the six constructs (~50%) that reflected learner situation awareness in collaborative mobile Web 2.0 learning. This indicates that the construct is of less importance in learner situation awareness. Interestingly, the results seemed to contradict with the views of Belkadi et al. (2012), where the researchers suggest that community awareness aspects are essential in computer-supported collaborative work (CSCW). Surprisingly, these results are also inconsistent with our initial perception that the a learner in a group is likely to make a decision based on what other group members are doing, have done, and are going to do. These results could be caused by the study’s limitation that restricted the public from accessing the learning community discussions thus causing the discussion to be contained in a “confined” classroom boundary. A more open mode of discussion could have resulted in different findings. Future studies could assess the impact of “open” and “closed” discussion on learner situation awareness. Moreover, the course was conducted in a blended learning environment. This may have been a contributing factor as to why the respondents regarded this construct as the least important. The use of a fully online learning environment could have yielded different results.

CONCLUSION AND IMPLICATIONS

In sum, the findings in the study revealed promising results in understanding learning situation awareness in collaborative mobile Web 2.0 learning. The study produced a learner situation awareness model that consists of six constructs (i.e., learning reflection awareness, learning community awareness, learning space awareness, social awareness, personal awareness, task awareness) and 33 respective indicators. Overall, the revised research model explained learner situation awareness in collaborative mobile Web 2.0 learning.

The model could be used as a foundation for future investigation in fields such as user interface design, pervasive computing, and teaching/learning in collaborative mobile Web 2.0 learning. In terms of user interface design, the research model could be used to design better user interfaces, which suit learners’ needs in order to enhance their learning process. For example, the indicators of the task, social and learning community awareness constructs could be utilized to design user interfaces that could improve coordination of learning tasks within group learning (Khuzaimah et al., 2015; Norman et al., 2015). For pervasive computing, the research model could be beneficial in terms of offering “right time, right place” assistance or solutions. This could be done by mapping the indicators of learning space construct to guide the context-aware information offered to learners during learning. For teaching/learning purposes, educators could use the indicators in the personal awareness construct to assess the emotional state of a learner during learning. For example, indicators such as motivation and confusion could guide educators in designing effective methods to moderate and intervene during the learning process.

Despite the promising results, this study has a few limitations. First, it only focused on learning from the student perspective while the role of the instructor was not investigated in depth. An interesting study would be to investigate the role change of instructors on an instructor-facilitator-peer continuum in which the instructor would have to assume different or combined roles in different learning situations. Second, the research model investigates collaborative mobile Web 2.0 learning in a blended learning course. Investigation on a fully online learning course could have produced different results. Third, the study focused on learner situation awareness in the domain of educational technology; future research could be carried out in different domains, which may yield promising yet unexpected results. The study was also limited in terms of learners' expertise as the learners were considered as novice learners. Including intermediate or expert learners could yield in interesting results. Fourth, the quality of learning outcome (i.e., videos) was not measured in the research model. Future studies could address and identify the relationships between such measures and the constructs of the research model. Fifth, the relationships between the constructs in the model were not confirmed with other tests such as the Covariance-based Structural Equation Modelling. Future studies could investigate whether correlations exist between the research model's constructs and indicators with a larger sample. Sixth, the study was conducted in an Asian context. Educators could study the cultural and social effect of different geographical context on collaborative mobile Web 2.0 learning. The values that certain countries nurture and practice might have a large influence on mobile Web 2.0 learning and its effect on learning and instruction.

ACKNOWLEDGEMENT

The study was funded by the Ministry of Education Malaysia.

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