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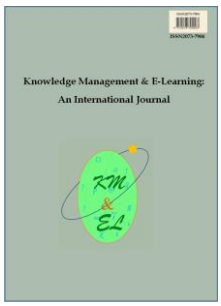

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The regulation of learning and co-creation of new knowledge in mobile learning

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Abstract: Mobile devices as learning tools enrich mobile computer supported collaborative learning (mCSCL). Engaging in metacognitive interaction promotes students' regulatory learning and this can provide a positive influence to learning outcomes. However, despite insightful empirical studies, there is no research into the actual processes of new knowledge creation in this context. This leads to the question of how mobile learning experiences can support the co-creation of new knowledge. Two classroom action research studies were carried out using a qualitative research approach. The analysis of the mobile messages using conversation analysis indicates that self-regulated learning in mCSCL is non-linear, defying existing theory. The findings also show that learners find ways to self-regulate learning activities in socially stimulated learning environments. Through knowledge sharing, students seek new insights into the learning instead of mere transfer of existing content. The Strategic Co-creation of New Knowledge in mCSCL Model has been developed providing innovative ways to approach mobile learning. The findings also comprise improved descriptive models in cross-boundary learning. This research is significant as emerging elements encourage instructors to rethink and design better mobile learning activities to optimize learning. Three recommendations are made and if implemented, will enable learning facilitators to achieve enhanced learning outcomes, engage learners better and improve learning experiences.

Keywords: Mobile computer supported collaborative learning; Mobile instant messaging; Mobile learning; Co-creation of new knowledge; Self-regulated learning

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1. Introduction

Mobile learning brings technologies into the classroom and can alter the fundamental way in which people connect and share information. Researchers such as Aliaño, Hueros, Franco, and Aguaded (2019), and Panjaburee and Srisawasdi (2018), anticipated major changes in education with the introduction of mobile technology. Research also shows that blended teaching strategies with mobile technologies transmute traditional teaching into innovative learning practices (Lai & Hwang, 2015), giving more attention to the learning process (Eger, 2018) and ultimately enhance student engagement (Ifeanyi & Chukwuere, 2018). Mobile learning thus brings along new practices and attitudes that socially engage learners in individual and collaborative learning activities. As learning content is no longer fixed to the classroom, and has now expanded beyond the curriculum, designing meaningful learning activities become crucial to involve students in real-life learning situations (Shelley & Goodwin, 2018). Seeing the potential educational value, Fu (2018) considered these changes in education are worth focusing and studying. However, despite the attention received in the field of education (Sung, Chang, & Liu, 2016; Zou, Xie, & Wang, 2018), existing research is diverse and poorly connected (Sharples, Arnedillo-Sánchez, Milrad, & Vavoula, 2009; Vázquez-Cano, 2014). Various studies have cited the benefits of using mobiles in mobile computer supported collaborative learning (mCSCL) activities. However, there is little research on the actual educational practices outside the context of research investigations (Roschelle, Rafanan, Bhanot, Estrella, Penuel, Nussbaum, & Claro. 2010). Mobile learning has been said to be accepted superficially without good understanding of the full potential (Graham, 2004). Conole, De Laat, Dillon, and Darby (2008) suggested that empirical research was required to examine the ways students use mobile technologies, like mobile instant messaging (MIM) to communicate, publish, share information and support learning. With little clarification on the role of interaction in mobile learning from a theoretical viewpoint (Wang, Chen, & Anderson, 2014), Al-Hunaiyyan, Bimba, Idris, and Al-Sharhan (2017) and Ebrahim, Ezzadeen, and Alhazmi (2015) lamented that current

implementations provided little knowledge on the delivery of learning materials and the educational process.

This lack of research prompted researchers like Ryu and Parsons (2012) and El-Hussein and Cronje (2010) calling for more research on the use of mobile technologies to facilitate collaborative learning. Specifically, Song (2014) suggested that current methodology approaches to mCSCL should explore how groups and individuals make sense of the new learning phenomena and new knowledge creation process in learning. Neier and Zayer (2015) reiterated on the lack of understanding in how students co-create value using mobile technologies. Eid and Al-Jabri (2016) claimed that the impact of MIM on knowledge sharing and learning among tertiary students had yet been well researched upon. Significantly, Sha, Looi, Chen, Seow, and Wong (2012) highlighted the need to include the role of learners in recognizing and analyzing the mechanisms and processes of mobile learning. Järvelä and Hadwin (2013) cited the lack in research on how individuals participate in group activities, especially in the regulated collaborative processes. Other than the few researchers like Winne, Nesbit, Kumar, Hadwin, Lajoie, Azevedo, and Perry (2006) and Järvelä, Näykki, Laru, and Luokkanen (2007), there is not yet any study on how mobile learning strategies support self-regulated learning (SRL) in the context of cross-boundary knowledge management. To narrow these research gaps and focus on the development of learners' higher-order thinking (Chang & Hwang, 2018), this study seeks to investigate mobile learning from the students' perspective and explores how the new learning behaviors can construct new knowledge in cross-boundary learning context using MIM applications.

2. Literature review

Learning is a dynamic two-way relationship between people and the social learning systems in which they participate. To advance learning, students need to move beyond their boundaries lying between different knowledge domains and practices (Akkerman & Bakker, 2011). Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, and Vavoula (2009) defined context-crossing as the change of physical or social setting. Nevertheless, it is still a challenge to engage in boundary crossing and collaborate beyond one's own profession and institution (Akkerman & Bruining, 2016). To discover learners' experiences, the socializing context is adopted. Fischer (2011) and Anderson (2008, p. 5) defined mobile learning as synchronous learning that "occurs through interaction between people and personal interactive technologies in an effort to generate new knowledge using mobile devices." Sharples, Taylor, and Vavoula (2007, p. 225) further defined mobile learning as a process of coming to know via interaction across multiple contexts.

Students' learning across formal and informal contexts reflect the changing of knowledge requirements for learning in society. However, with traditional practices of schooling still prevailing, the concept of cross context learning is still not well dealt with. By restricting learning to one setting would overlook focal interdependencies between multiple settings in learning. Traditional learning context has experienced radical changes in teaching and learning. New alternatives to education and training systems have emerged with greater collaboration between schools and corporations. When learning activities gradually move into the practical sphere, context crossing takes place making mobile learning socially interesting. Hence, the organizational context becomes indispensable in the studying of mobile learning. Rethinking mobile learning in terms of context crossing gives a new perspective in defining mobile learning.

In this study, mobile learning is defined operationally as a mobile supported social collaboration process where learners with their personal communication tools engage in interaction with and beyond one's boundary to share and generate new knowledge. This definition embeds the concepts of mobile learners, mobility of technology and learning and new knowledge creation of the learners. It explains underpinning processes through which learners create meaning through exploration and discussion. The process is mobile in nature and transcends physical and conceptual boundaries around conversation to allow learners to build linkages between experience and the concept to generate new knowledge. Therefore, in this research, new knowledge is socially formed when people interact with others who possess the desired knowledge and expertise.

2.1. Mobile computer-supported collaborative learning (mCSCL)

Advanced mobile applications have opened new possibilities for mobile based collaborative learning (Zeman, 2011). mCSCL is defined as using mobiles to enhance the collaborative and cooperative learning that comprises of a small group of students working together to make best use of their own and other's learning (Resta & Laferrière, 2007; Stahl, 2006; Zurita & Nussbaum, 2004a, 2004b). There are many ways to use mobile technologies in the collaborative learning context (Hsu & Ching, 2013; Laurillard, 2009; Stahl, Koschmann, & Suthers, 2006) and they are popularly and widely used for educational purposes (Rau, Gao, & Wu, 2008). mCSCL is mainly text-based and enables students to freely convey views and ask questions unlike the sense of restriction to seek help in traditional classrooms (Kitsantas & Chow, 2007; Rau et al., 2008; Ting, 2013).

Metacognitive, social and other interactions are the three categories of interactions in mCSCL environment (Kim, Lee, & Kim, 2014). Of these, metacognition requires higher-order self-regulated mental processes. In metacognitive interaction, students engage in interactive activities that involve the controlling, assessing, and revising of their team member's cognitive processes. Conversing among students, teachers and members of Communities of Practice (CoPs) 'have an important role as triggering elements for individual cognitive processes' (Valtonen, 2011, p. 22). Learners reflect on their existing and new experiences to improve and fine-tune their world's view.

2.2. Cross-boundary mechanisms in mCSCL

Learning, an interplay between personal experience and social competence (Wenger, 2000), involves boundaries and connected communities that can offer learning opportunities (Wenger, 2000, p. 233). Boundary is the "sociocultural differences that give rise to discontinuities in action and interaction" (Akkerman & Bakker, 2011, p. 139). With mobile phone as a boundary crossing tool (Pimmer, 2016), boundaries of practice are no longer geographically confined (Wenger, 2010). Mobile technologies facilitate learning across more diverse and peripheral network spaces. This in turn, fosters interlinkage between formal knowledge in the academy and informal work processes in the practical world (Akkerman & Bruining, 2016). Mobile and wireless technologies make possible out-of-class learning to be connected directly with the practical world. However, education research mainly studies learning within boundaries of practices which focuses on one domain or group of expertise (Akkerman & Bakker, 2011). For students to advance in their learning, they need to move beyond their boundaries between one's subject domain and the realm of pedagogical theories and knowledge (Akkerman & Bakker, 2011). The concept of context-crossing has also been mentioned by Wali et al. (2008). Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, and Vavoula (2009)

defined context-crossing as the change of physical or social setting and the mobility of crossing physical and social spaces is perceived as central to mobile learning.

2.2.1. The boundary mechanisms of identification, coordination, reflection and transformation

There are four cross-boundary mechanisms in mCSCL; identification, coordination, reflection and transformation (Akkerman & Bakker, 2011). Interaction opens up our identities to other ways of being in the world (Akkerman & Bakker, 2011, p. 252). When being uncertain of their own knowledge domain due to similarities or overlapping between practices of other domains, individuals will enact on their identification mechanism (Akkerman & Bruining, 2016) and reconstruct their knowledge creation between boundaries to renew their identities as knowledge builders (Yeo, 2014). In this study, identification takes place when students realize that for continuous learning to take place, they need to understand practical practices outside their own domain by identifying the appropriate person in the professional field.

Coordination involves some forms of networking and communication between various practices or viewpoints (Erstad, Kumpulainen, Mäkitalo, Schrøder, Pruulmann-Vengerfeldt, & Jóhannsdóttir, 2016). To share multiple perspectives, communication is a requisite (Landa, 2007). It allows smooth transition of diverse practices to establish new exchanges and routines that align activities (Bruining, van den Eijnden, & Akkerman, 2012). When boundary crossing learning becomes a way of learning and practice, students will acquire skills to interact in cross-boundary learning contexts. The portability and multi-media capturing features of mobile technology permit learning to become space independent. The coordinated work can then be easily distributed and shared in socio-cultural, disciplinary and physical settings (Pimmer, 2016). In this study, coordination arises when students and their external learning partners find effective ways to enable cooperation. This in turn, bridges work and schooling experiences.

Reflection encompasses learning and respecting the viewpoint of the partner from feedback received. Reflection as the "capacity for higher-order thinking" enables one to make connection to what they are thinking (Denton, 2011, p. 838), and that allows mutual definition of different standpoints and readiness to accept different opinions (Bruining et al., 2012). The making and taking of perspectives help to build and comprehend new viewpoints. Reflection thus enables students to comprehend and adopt new perspectives and learning practices. Transformation implies some maintenance of the original special practices and perspectives and incorporates the supplementary values from the joint work (Akkerman & Bruining, 2016). For this study, transformation comes into effect when students modify learning practices to incorporate the newly simulated learning practices. With enhanced understanding of the four mechanisms, the next question is to explore how these changes affect the regulation of learning across contexts.

2.3. Self-regulated learning in mCSCL

Self-regulation is the awareness and adaptive behaviors of a learner in the learning process to attain a desired goal (Schunk, Meece, & Pintrich, 2013). As an essential skill for student to collaborate in learning, it denotes the regulation of learning based on collective metacognitive monitoring and control of cognition, motivation and behavior (Hadwin, Järvelä, & Miller, 2011). Performing group task together signifies the co-construction of shared task, goals, and approaches. Without this sense of shared task and goals, collaborative work may be disrupted, and students are likely to experience

dissatisfactory learning experiences and unable to enjoy their learning (Hadwin et al., 2011). In collaborative learning settings, students' active engagement in collaborative interactions are perceived as supporting group's directed engagement in the shared task space (Roschelle & Teasley, 1995).

Although students can learn on their own with the help of educational technology, at tertiary level, they are often encouraged to work in groups to solve problem and work collaboratively on assigned shared task. In this sense, the work of group members impacts their own regulation and cognition in the learning process. With mobiles as learning tools among university students, the computer-supported collaborative learning framework for self-regulation needs to be extended to explore the potential of mobile-supported environments in enhancing regulation for mCSCL. To provide a mechanism to structure collaboration in a mobile environment, Self-regulated Learning Theory (SRL) can help regulate, monitor, and control the various aspects that affect the learning process and evaluate learner's learning behaviors. SRL can be interpreted conceptually in terms of learners' cognitive, metacognitive, behavioral, emotional and social involvements (Zumbrunn, Tadlock, & Roberts, 2011; Zimmerman & Schunk, 2008). To navigate learning experiences, SRL is an important indicator of student academic motivation and achievement (Zumbrunn et al., 2011).

Traditionally, self-regulation research in learning focuses on the individual stance but there is now a growing interest looking into the mental activities in self-regulated learning at the social level (McCaslin, 2004). Zumbrunn et al. (2011) indicated that the teaching/learning process involved not just cognitive components, but also social components. With increasing use of technology, researchers start to examine how learning technologies can support or promote students' self-regulated learning (Dabbagh & Kitsantas, 2012; Hwang & Chang, 2011; Kitsantas & Dabbagh, 2011; Nicol, 2009; Sheppard, 2011). Nevertheless, it is not easy to achieve good coordination as individual members in the group regulate cognitively and emotionally in the process and this is a challenge in socialized interactive context (Järvelä, Volet, & Järvenoja, 2010).

2.3.1. Three prospects of self-regulated learning

From the social cognitive perspective, SRL is the level of pro-activeness and responsibility on the part of the students towards their learning process (Zimmerman, 2008). The SRL Theory is used to study how technology assists students to improve learning tactics and control one's learning process on individual and social levels. There are at least three types of regulated learning when individuals work collaboratively. Järvelä and Hadwin (2013) linked these perspectives of SRL to successful collaboration requirement stating that individual member was in charge of regulating one's learning. According to Järvelä and Järvenoja (2011), the three prospects are as follows:

a) The individual as a regulator of a behavior. It is a process of becoming a tactical learner by regulating their reasoning, drive and behavior to improve learning (Schunk & Zimmerman, 1994).

b) SRL as a co-regulation process. Influenced by socio-cultural theory, co-regulation stresses on the steady adoption of sharing common problems and tasks through interpersonal communication (McCaslin & Hickey, 2001; Schunk & Zimmerman, 1994).

c) Shared regulation as collective processes. It is the co-establishment of common understanding (Roschelle & Teasley, 1995) where groups create shared awareness of aims, advancement, and tasks.

Pintrich (2000, p. 453) cited that self-regulated learners who actively select and set goals allowed themselves to develop strategies to manage and evaluate the learning process and performance. The appropriate use of learning strategies depends on past learning experiences and therefore, it is adaptive (Hadwin, 2013). SRL is also guided by environmental circumstances (Schunk & Zimmerman, 2012) whereby teamwork requires each group member to self-regulate one's cognitive processes, actions and beliefs (Hadwin, 2013). As proactive learners, individuals are stimulated by their impulses and external environments to self-organize their learning (Bandura, 2001; Martin, 2004). Taking this stand, it assumes that engagement in learning is mediated by learners' personal factors such as prior knowledge, goals, and self-perception of the task. Co-regulation in collaborative learning occurs when individuals' regulatory activities are supported, directed, or limited by and with others in the group (Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007). It is commonly influenced by student's own self-regulation and the regulation from other sources such as teachers, peers, curriculum materials and assessment instruments on student learning (Allal, 2011). Hence, to accomplish mutual understanding and collective goals, learners engage in dynamic interaction through co-regulation in collaborative learning. High-level co-regulation is normally led by a question or an explanation (Volet, Vauras, & Salonen, 2009) Co-regulation is a necessary step to ensure productive collaborative learning (Winne, Hadwin, & Perry, 2012). However, research on co-regulation has received scant attention in the field of CSCL (Dillenbourg, Järvelä, & Fischer, 2009) and not much is known specifically on the behavioral patterns of co-regulation. Zheng and Yu (2016) recommended that future research was needed to analyze learners' cognition, emotion, and social interactions, in conjunction with knowledge construction combined with their behavioral patterns.

Socially shared regulated learning (SSRL) is a 'new and growing field' in the framework of SRL theory (Panadero & Järvelä, 2015, p. 2). SSRL occurs when groups regulate together collectively (Panadero & Järvelä, 2015). Groups deliberately and strategically make adaptation during phases of collaboration in terms of negotiating common task perceptions, aims, plans, and methods (Hadwin, Järvelä, & Miller, 2011). According to Rogat and Linnenbrink-Garcia (2011), SSRL maintained optimistic socio-emotional communication during teamwork by listening to and taking each other's opinions into consideration. As it involves multiple individual perspectives, working together in the shared regulatory processes, refinement of cognitive, motivational and emotional conditions is needed to derive at a shared outcome (Hadwin et al., 2011; Panadero & Järvelä, 2015). Hadwin et al. (2011) conceptualized SSRL in four loose sequences that were linked to feedback circles. The group can make alterations to their task after monitoring their activities. The group can adjust their thoughts of the task, goals, plans, or tactics to lift their collective activity towards the shared learning goal. Basically, when groups participate in SSRL, they broaden their regulatory activity from the ''I'' to the ''we'' level, suggesting their support in the collective activity (Hadwin & Oshige, 2011). This "transfer in sharing" during SSRL is vital to successful collaborative learning as cited by Malmberg, Järvelä, Järvenoja, and Panadero (2015, p. 4). With respect to the use of mobile devices, insights into the interactive pattern in co-regulation will provide greater understanding and guidance for instructors' recognition of how various co-regulatory online behaviors contribute to excellence in learning.

As mentioned by Sha, Looi, Chen, and Zhang (2012), knowledge and skills of SRL are the antecedent to mobile learning, and one of the anticipated outcomes of mobile learning is the design and application of mobile learning systems that fit the principles of SRL. Mobiles devices can be used as cognitive tools (Chen, Tan, Looi, Zhang, & Seow,

2008) and metacognitive tools for learners (Sha, Looi, Chen, & Zhang, 2012; Sha, Looi, Chen, Seow, & Wong, 2012). For this research, to understand the mCSCL, it is essential to apply the Self-regulated Learning Theory in which learning behaviors can be tracked through behavioral patterns and interactions to understand the very subjective metacognitive thinking of learners in the way they collaborate on a mobile platform for new knowledge co-creation. When the model of the self-regulated learner is extended to include mobile technology as a learning tool, the skill set also includes the ability to learn in collaborative contexts as well as being able to engage in the construction of knowledge with access to the internet at their fingertips. As depicted in the conceptual model, these learning patterns and behaviors become vivid when transformed from self-regulated to co-regulated learning and socially shared regulated learning bases. The integration of learning enriches as learners engage in more active discussion and interaction becomes dynamic and spontaneous on a mobile and social network basis.

2.4. From knowledge construction to New knowledge co-creation

From a constructivist perspective, Naismith, Lonsdale, Vavoula, and Sharples (2004, p. 2) viewed learning as an active process where students constructed new ideas or concepts using their present and prior knowledge. Students are encouraged to be "active constructors of knowledge". Constructivism advocates that individually, students can mentally construct the world of experiences via their cognitive processes, while social constructionism takes a more social and less individual approach (Young & Collin, 2004). Social constructivism reflects how individuals jointly understand and gain knowledge of the world. It perceives human knowledge as socially constructed through social processes and actions (Young & Collin, 2004) and how a student interprets this knowledge is influenced by the social and cultural contexts to which the knowledge is constructed (Hung, 2001). Based on the social constructivist theory, technology enables learning approaches to situate the learning and application of knowledge stressing on problem-based instruction, mutual teaching, collaboration among peers, cognitive apprenticeships, web quests, anchored instruction, and other methods that involve practitioners or community of learners (Schunk, 2000). Aldoobie (2015) further stated that there would be greater impact of social constructivism if the theory was integrated with technology. Social interaction is an important factor in collaborative learning. Social learning theory stresses that learning happens within a social context, where people learn by seeing and following other learners' behaviors (Hung, Looi, & Koh, 2004). Collaborative learning can help to strengthen learner engagement (Gokhale, 1995) and stimulates higher-order thinking for critical thinking to take place.

Social learning can be experienced in mCSCL since mobile learning enables seamless social interaction in learners by providing them advanced functions such as mobility and instant connectivity (Ryu & Parsons, 2012). The development of mobile applications opens new possibilities for mobile based collaborative learning (Zeman, 2011). Mobile technologies provide the opportune for students to develop SRL skills (Mueller, Wood, De Pasquale, & Archer, 2011; Paris & Paris, 2001). When self-regulated learners engage in social mobile learning, their skill set widen to include the ability to learn and construct new knowledge with access to the internet. Neier and Zayer (2015) noted that social media networks could potentially be effective for students to involve, discover and share ideas to form co-creation platforms (Grönroos & Gummerus, 2014). In the digital communication platform, students can negotiate opinions with group members leading to knowledge construction (Beers, Boshuizen, Kirschner, & Gijselaers, 2005; Van der Meijden, 2005; Schellens, Van Keer, De Wever, & Valcke, 2008). The co-creation experience itself may provide value and, in the education contexts, value may

continue to emerge over time. However, as mentioned by Dean, Griffin, and Kulczynski (2016), this is an under-researched field.

The concept of co-creation originates from the field of business (Ramaswamy, 2009). Hemsley-Brown and Oplatka (2006) suggested that the co-creation concept could be applied to the higher education sector. As more formal or informal interaction takes place over the internet, information searching becomes more complex involving two-way interaction and human guidance (Mills, Knezek, & Khaddage, 2014). Considering the significant influence of deep learning and the importance of cognitive engagement by the learners, studying the new knowledge co-creation process is crucial to elevate students' learning to higher order of thinking skills (HOTS) according to the revised Bloom's taxonomy (Anderson et al., 2001).The co-creation experience itself may provide value, and value may continue to emerge as learners reflect and engage in further value-generating processes (Dean, Griffin, & Kulczynski, 2016). This new knowledge creation phenomenon in the current mobile learning environment signifies a need to better understand how students behave and learn with appropriate mobile learning designs.

3. Research objectives

This study captures the actual learning processes in the construction of new knowledge using MIM applications and reveals the dominant patterns of interactions among students in group-based mobile learning activities. To identify the students' strategies in constructing knowledge, the SRL Theory is adopted to show how regulated learning behaviors and mobile learning experiences co-create new knowledge for effective learning. The findings give better insights into how students perceive mobile learning and how new behaviors alter learning processes. As such, the followings are the research objectives:

a) Understand mobile learning from students' perspective
b) Investigate students' knowledge construction behaviors in mCSCL
c) Identify factors influencing knowledge construction in mobile learning context
d) Study students' self-regulated learning strategies for co-creation of new knowledge in mCSCL discussions

The research asks the following questions:

1) How do students perceive mobile learning?
2) How do learners self-regulate learning in mCSCL?
3) What factors influence mobile learning in knowledge construction?
4) How does self-regulated learning facilitate the co-creation of new knowledge in mCSCL?

4. Method

4.1. Pilot study

The study is founded on a qualitative research comprising of a pilot study and two classroom action research interventions. The pilot study was conducted on a homogeneous sample group of 7 international students from a Thai university. The

participants were purposively selected because they had experienced the phenomena and the research question addressed to them were meaningful. As such they could best inform the research questions to enhance the understanding of the phenomenon under study (Creswell, 2009). The focus group interview is a powerful way of getting insights into interviewee's perceptions (Ho, 2006). The small number of participants in the study (typically less than 10) enables a detailed micro-level interpretative analysis of the participants' accounts (Smith, Flowers, & Larkin, 2009).

4.1.1. Sample selection

The participants were knowledgeable about and had experienced the phenomenon of interest (Creswell & Plano Clark, 2017). They were available and willing to communicate experiences and opinions in an articulated, expressive, and reflective manner (Bernard, 2017; Spradley, 1979). Participants were 3rd and 4th year students who had attended courses that incorporated mobile learning as instructional method. Participants' ages ranged between 21-24 years, and they were all females. They represented a variety of backgrounds in terms of country of origin, and English language proficiency. As key informants, they were able to provide credible information on their usage of mobile technologies for learning. To improve the instrumentality and address potential biases, the researcher followed McNamara (2009) principles in interviewing by first choosing a setting with little distraction, then explaining the objectives of the interview and addressed terms of confidentiality as well as the interview format. The researcher also made effort not to inject opinions and into the conversations (Bradbury-Jones, Sambrook, & Irvine, 2009).

4.1.2. Data collection and analysis

In terms of data collection, participants texted and provided first-hand mobile learning experiences to convey thoughts and opinions into valuable information for the study (Turner III, 2010). Participants were invited to join a chat group and upon acceptance, the purpose of the discussion was texted to them. Line is a freeware app for instant communications on electronic devices. It is popularly and widely used around the world. Students see the application as a more efficient and motivating system to face and receive prompt responses from their teachers (Li & Liu, 2017) Using MIM is seen as an appropriate tool for communication and a place for communication which reflects the way of being in the world (Silverman, 2016). The data were digitally captured from the messages on the group Line. To ensure internal validity of the research, the researcher followed the pilot study procedures closely in several ways such as gaining feedback to identify doubts, recording time used to complete schedules and re-piloted as recommended by Peat (2001).

Due to the subjectivity of topic, a semi-structured interview design process was adopted (Kvale, 1996). All participants received texted messages that included an identical set of eight prepared open-ended questions and probing questions were asked for further elaborations. The questions range from perception of mobile learning, preferences of using instant messaging for learning, views on differences between formal and informal interactions, the ways mobile learning enable the sharing and creation of knowledge, the regulation of learning using mobiles, the co-creation of new knowledge in mobile learning and the value associated with mobile learning. The in-depth focus group interviews were conducted in English and in three different sessions. The repetitive cycle, occur concurrently with the analysis of the iterative cycle, enables the researcher to document emergence of new themes and identify perspectives that may otherwise be

overlooked (Sargeant, 2012). The cyclic process enables the examination of similarities and differences in views (Polit & Beck, 2009).

The duration of the three interviews were one hour, two hours and one hour 35 minutes respectively. In all occasions, both researcher and participants were in the same locations with mobiles on hands. Data were collected and transcribed via a process of categorization based on participant perspective code (Polit & Beck, 2009). Using interpretive phenomenological analysis, and attaching significance to what was found (Patton, 2002, p. 480), the codes were deconstructed, interpreted, and reconstruction (Miles & Huberman, 1994) to facilitate the understanding of the mobile learning phenomenon from the students' perspective (Sargeant, 2012).

4.2. First classroom action research

To continue the study, classroom action research (CAR) was selected for the purpose of collecting rich data and enabling the teacher cum researcher to comment on classroom process at hand to improve classroom practices. To conduct CAR, teachers identify the areas for improvement, and address them through the practices of inquiry, action, reflection, and sharing (Capobianco & Feldman, 2010). The repeated cycles of research action have helped in the development of understanding and induced changes in mobile learning while enhancing learning experiences for both researcher and participants (Shelley, 2012).

4.2.1. Sample selection

In the first CAR, a class of 14 international students were purposively selected based on their exposure to the mobile learning course design. The participants, 12 females and 2 males, were second year university students whose age ranged from 18 to 24 years. They voluntarily grouped themselves which formed the three cases in this CAR. The first group comprised of four participants, the instructor and an external learning partner. The second and third group, both had three participants and an external learning partner each. For the latter cases, the instructor was not invited to join the conversation but was kept in the interaction and feedback loops.

4.2.2. Data collection and analysis

Using social apps, participants engaged in instant messaging to discuss approaches in charity works. One local learning partner and two from abroad were involved in the mobile interactions. The external learning partners were selected based on working experiences in the field of interest and they were chosen either from students' own or referral network. The duration and content of interaction were determined by the participants and their external learning partners. In all groups, the instructor adopted an observer role with minimal interference in the interaction process (Odierna & Bero, 2014).

To envisage regulatory learning patterns, their mobile interactions over their mobile learning activities were captured and analysed using Conversational Analysis (CA) (Easterby-Smith, Thorpe, & Jackson, 2015). CA allows the extraction of reliable and credible results from text data which enable the creation of new knowledge and ideas, presentation of facts, compression of extensive descriptions of a phenomenon, results in concepts and descriptive categories (Hsieh & Shannon, 2005). The researchers sorted and

sequenced the contents according to effort to acquire knowledge (Carver & Scheier, 1981), control of learning and accepting responsibility for achievement outcomes (Pintrich and De Groot, 1990), flow and timing of interaction, interactive content (Butler, 1998), peer interaction (Liu, Chung, Chen, & Liu, 2009), student- teacher interaction (Al-Shehri, 2016), social interaction (Vavoula & Sharples, 2009), learning strategies (Zimmerman & Pons,1986), feedback cycle (Ferrell, 2013), acquisition and construction of knowledge, and knowledge sharing procedures.

Making sense of the ongoing sequence of utterances, the researcher discovered and described the order of regulated learning based on the rules and practices in SRL (Zheng, Kumar, & Kinshuk, 2014). The unit of analysis was the block of text from the MIM interactions of each group. The data was analysed to highlight underlying meanings, following the sequence and structure of the text (Denscombe, 2014). The use of CA helped to determine if the current model of SRL was applicable in the mobile learning environment. If there was a variation in terms of behaviors and patterns, what would be changed and how these changes would influence mCSCL for effective learning.

4.3. Second classroom action research

To uncover how students regulated learning behaviors accelerate the co-creation of new knowledge process, a second CAR was carried out in another course and with a new group of students on the following semester.

4.3.1. Sample selection

Like the first CAR, a class of second year students in the same faculty, were purposively selected based on their exposure to mobile learning course design. The class comprised of a group of 21 international students, 18 females and 3 males, age ranging from 18 to 24 years. Similarly, using their social apps, participants engaged in instant messaging to conduct their discussion in a cross-boundary context. Participating students were assigned to identify potential external learning partners to explore work and living experiences of people in different countries. External learning partners were selected based on personal network or through references provided by the instructor. The activity signified cross-boundary learning over space as participants engaged in co-regulated learning.

4.3.2. Data collection and analysis

Likewise, the unit of analysis was the cross-boundary interactions of the students. The level of construct was at group level. The data collected was based on multiple sources through the recorded text messages, observations, discussion and interviews. Research data collected comprised of MIM interactions during the learning and sharing processes as well as the reflective reports of the participants. The researcher studied recurring themes, citing supporting evidences. The data was analysed using Saldaña (2015) 'codes-to-theory model' for grounded analysis as cited by Easterby-Smith et al. (2015). During this process, the researcher identified emerging themes, coded and categorized them. These initial codes and categories were tentative and changed as the analysis moved forward. After initial coding, the researchers took time for reflection by means of writing analytical memos (Saldaña, 2013, pp. 100-101).

To complete the learning activity, students individually reported on what they had learned. The feedback allowed the researchers to gain insights into how students

perceived the activities, task preparation, effort made, apprehensions and strategies to improve performance. In both CARs, reflection was an integral part at all stages in the process; the researcher revisited previous stages and made cross references to the regulatory learning behaviors and patterns, improving on the learning design to build up the learning activities and enhance the mobile learning approaches.

5. Findings

5.1. RQ1: How do students perceive mobile learning?

The findings of the pilot study comprised many reflections from the students that are useful in developing a more balanced definition that geared towards the 'why' and 'how' dimensions to reflect active learning which signified an effective learning process (Shelley, 2017). Mobility of learning was mentioned by all participants and they described their mobile learning experiences positively, with only one exception about possible distractions.

5.1.1. Greater social interaction in mobile learning activity

Participants acknowledged that the use of mobile devices was an important component in their learning process, particularly with the ease of getting information. They reckoned that mobile learning "did not limit the course in the class only". One participant related mobile learning to "change management" in terms of course design as she cited that it "changes in the way things were done inside and outside the class". This statement was critical because it demonstrated the student's expectation in her learning involvement and emerging practices in university curriculum. The participant further added that "if you interact outside the class, you got to know a lot about their situations and thinking they went through outside the class". The call for innovative means to how lessons and academic contents should be delivered in school, signify the desire of students to be engaged in more authentic form of learning.

5.1.2. Wider learning boundaries

When asked how mobile was used for learning, a student stated that "I think it opens up the classroom space". The opening up of the classroom space signified the expansion of the learning boundaries. Recalling her learning experience, the student reflected that "this class project actually allows me to overcome the geographical barriers to understand someone far from me". Another two students explicitly mentioned the keywords crossing the "physical and space boundary" for learning and understanding. Student also said that "technology has made my learning more productive and I am confident to talk about my work". Using the metaphor of 'step-out' and 'step-in', student associated mobile learning with the boundary mechanism in learning space when she said that "this class project actually allowed me to 'step-out' of my physical restriction and 'step-in' to the virtual space to understand someone far". The cross-boundary learning task was thought to be "an interesting method to gather information". It was thought as an "extensive learning method". The extensity or geographical coverage of the learning implied that the learning was beyond the curriculum.

5.1.3. Learning becomes more interactive and enjoyable

Participants also highlighted that the new learning culture and behaviors, that evolved through interaction made mobile learning enjoyable. They became more engaged in their learning as they put effort into reading the content or information Students further disclosed that effective learning could be socially constructed through the interactions which were not part of the original course content. Reflective insights and evidence of social learning emerged from students' interactions included metaphorical statements such as, one could share and get information from an "island" or a "jungle" implied that learning was not restricted in classroom and could come from virtual interaction. The desire for greater informal interaction was reflected by a participant's frustration towards traditional learning claiming that the fear of making mistakes hesitated one to ask and answer questions. Indecisiveness in class participation was perceived as a hindrance to establishing stronger bondage with teachers as well.

Nevertheless, the sense of pro-activeness in learning was detected when a participant orated that "whenever I had a question, I could just text my teacher and she would come back to me with a useful answer. This is of great value!". Learning also took place outside class in terms of communicating, planning, and execution of task according to the participants. The use of social media had enabled them to coordinate work as mentioned by one participant that "there was no mentioning of anything in books, but we did learn by doing the campaign. It was about management and planning." The participant added that "building on others' opinions in order to create one's own was a fundamental part of the learning process". The idea of a more knowledgeable person to interact with for knowledge indicated how learner proactively searched the right person to interact for learning. This added another key concept to regulatory learning when she commented that "Texting with a person who had knowledge gave you the opportunity for a two-way communication". This line of thought reinforced the theme on the value in learning.

5.1.4. Facilitating role of teacher

Participants saw the use of social media and mobile applications as bridging the gaps between teachers and students citing that their teacher was reachable via the Line application. Apparently with mobile learning, participants envisaged a greater role of the teacher in the facilitation in their new learning process. There was also the belief that information provided formally, should be reinforced informally with feedback. The need for feedback had surfaced as a prominent theme as participants saw how mobile learning shaped the path for meaningful learning. This highlighted the importance of the facilitator effort to ensure the ongoing of the interaction. This sense of pro-activeness in learning was detected when a participant "orated" that "whenever I had a question, I could just text her (teacher) and she would come back to me with a useful answer. This is of great value ….". The statement made was crucial as it indicated the collaboration value participants perceived in their course of learning with mobiles. Learning facilitation with students throughout the learning process, rather than being restricted to classroom interactions was a change that some teachers might reject.

5.1.5. Greater engagement in regulated collaborative learning process

In creating new ideas, one participant explained that face-to-face interaction was much more effective as "we could actually encourage one another to participate and contribute". However, when communication took place online, "it solely depended upon the student's

initiative.". This sentiment was a reflection of the participant's personal experiences. Adding on to the regulatory in learning, one participant specifically texted her experience in selecting people to assist her study at odd hours cited that "I studied until midnight for my final exam and it was impossible to ask for help on a face-to-face basis (at that late hours). So, I turned to Facebook Messenger to ask my friend from Canada". The self-regulation in her learning process was reflected in the way the student overcame the barrier of time and optimized time differences to her best benefit.

5.1.6. Greater value in the co-creation of new knowledge

In terms of co-creation of new knowledge on MIM, one participant described co-creation as a new platform to opinion sharing and discussion claiming that "I could absorb the knowledge more naturally and I believed the mobile way could enhance my point of views and knowledge absorption." This perception is in line with the research of Tsoukas (2009) that knowledge creation is embedded in social interaction and dialogue. On how they could co-create, another participant explained how her initiative to engage in a cross-boundary interaction gained new understanding to a problem and how this knowledge was socially shared to co-create new knowledge. The same participant related her mobile interaction with a Peru teacher whom she met in her student exchange program. A mobile conversation provided the needed explanation to the effectiveness of the campaign in Peru. She texted "Finally, I got a good idea and I shared (what I leaned) with my classmates and teacher. Everyone in class received new knowledge". As for this student, the value of co-creation was "1+1>2" as she felt that "we conducted interaction, we shared our ideas and those ideas might create new ideas to others and more new ideas were created". From this perspective, knowledge is co-created by the process of interaction and mobile technologies indirectly enable re-experiencing to materialize. The participant further added that "co-creation taught me how to pick the key information out of communication. I knew the important of information flow to generate more ideas to make me studied more efficiently." This learning experience connotes that knowledge is deeply embedded in the technological and social context of a community that creates and reproduces knowledge (Nonaka & Konno, 1998; von Krogh, Ichijo, & Nonaka, 2000). Hence, in this learning context, co-creation not only reinforced the new learning but also generated greater impact on joint decision making, placing emphasis on knowledge management especially in selecting essential information, conceptualizing new ideas and applying the knowledge for effective learning outcomes.

The insightful interpretative accounts of experiences brought to light six emerging perspectives which helped to answer the first research question on the students' perspective on mobile learning. These perspectives were beyond technology and functionality of mobile devices as learning tools. These perceptions presented in Fig. 1 helped to answer the research question on how students perceived mobile learning. Once learners understood the impacts of socializing around the concepts being discussed, they then could comprehend how learning could be enhanced with mobile devices.

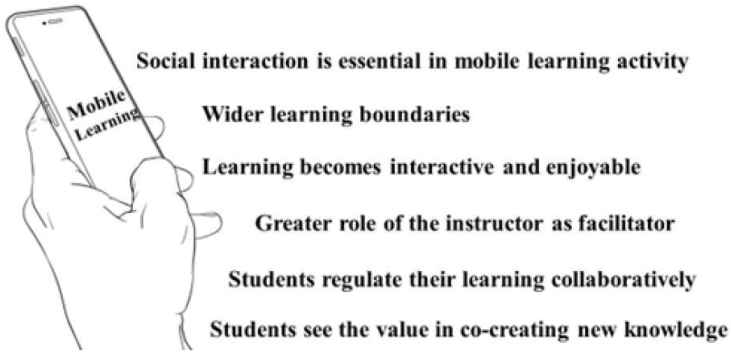

Fig. 1. Students' perspectives of mobile learning

With the new insights, the researchers refined the definition of mobile learning as a mobile supported socially regulated collaborative learning process, whereby learners with their personal communication tools engage in interaction with and beyond one's boundary to share and co-create new knowledge. This new definition embeds the elements of mobile learners, mobility of technology, mobility of learning, regulation of learning and new knowledge creation of learners. It underpins the processes through which learners create meaning by exploration and discussion. The process is mobile in nature. Transcending the physical and conceptual boundaries via conversation, allows learners to build the link between experience and concept to create new meanings. The definition reinforces the impact of social learning and the co-creation of new knowledge in regulated collaborative learning.

5.2. RQ2: How do students perceive mobile learning?

There were three cases in the first CAR. Based on the conversational analysis, it was discovered that the conversational structure did not conform to the existing model of SRL. In the first case study, the regulation of learning was clear and strong. Even though all participants were in different locations in terms of specific locality and or country, the flow of communication was non-chaotic and was well supported by all participants. All participants actively engaged in the collective activity making group decisions and supporting each other in the questioning session. There were no distinct differences in terms of their collaborative efforts in class or out of class. The sense of socially regulatory learning was clearly demonstrated among these students. It was further strengthened in the formal learning setting. Students voluntarily supported each other for better performance. SRL behaviors re-emerged with the reflective reports by the students as well as during the feedback session with the instructor. The flow in the regulation of learning in case 1 is presented in Fig. 2.

Unlike case one, the regulation of learning in case two, as depicted in Fig. 3, started with the team leader initiating the interaction with the interviewee on her own personal Line application. She shared the learning through screen capturing and posted the text messages to the group Line and this was how co-sharing occurred. When students co-regulated their learning, they were able to organize the information and prepared the presentation with links provided from their learning partner. Case three, presented in Fig. 4, was quite different from the other two cases. The number of questions asked were relatively less than in case one. However, the distinction was that the external learning

partner asked an equal number of questions to the students to gauge their understanding. External participants' SRL were assisted by the reflective questioning, encouraging them to engage in critical thinking. An array of insights was discovered with several positive implications.

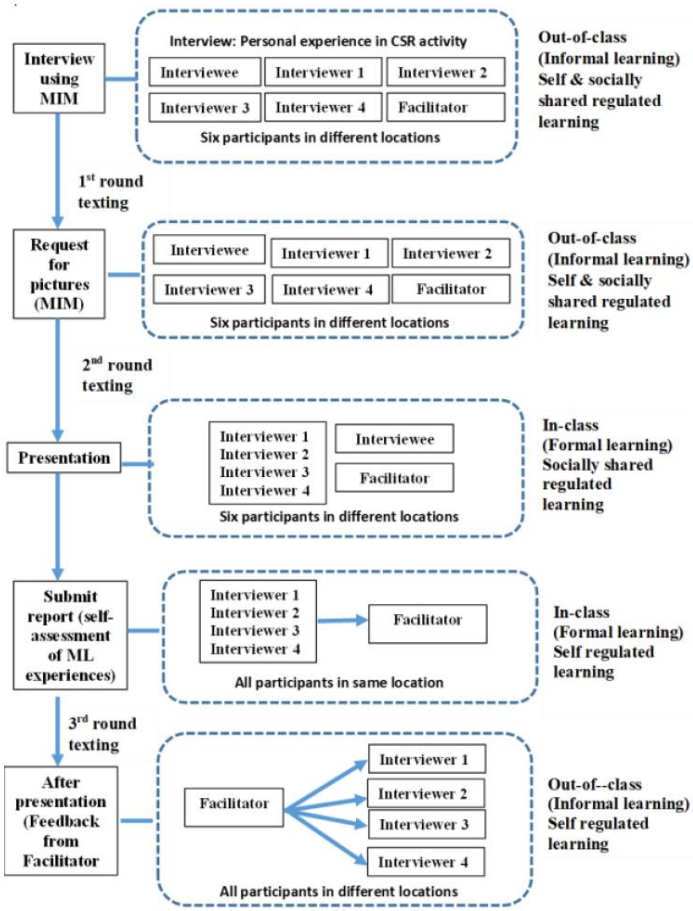

Fig. 2. The flow of interaction in case one (First CAR)

The self-regulatory or intra-personal regulation (Grau & Whitebread, 2012) in learning is the accepted behavior of a student regulating his/her own learning without the intention to influence other students. It is often understood that when students work in pairs or groups, they must move into the co-regulation or inter-personal concept of regulation and socially share regulation with "multiple others regulating their collective activity" (Hadwin & Oshige, 2011, p. 254). If this is so, the regulatory process is rather linear as suggested by existing SRL models. However, from the first CAR, it is clear that the regulation of learning for individuals is not linear and sequential as suggested by Järvelä and Hadwin (2013). The research supports an SRL model that is multi-dimensional and complex. This highlights why traditional teaching models are limiting in modern learning environment (Dovey & Fisher, 2014; Snehi, 2011).

With mobiles, it makes sense to stimulate learning and co-creation of new insights rather than remaking in one-way transfer of existing knowledge. How students learn with

mobiles is an individual process; it is not individualistic but closely linked to learning context as this research has indicated. This is an important detection as it provides the support for the theorization of mobile learning process. This comprehension helps to answer the second research question of how learners use mobiles to facilitate learning processes.

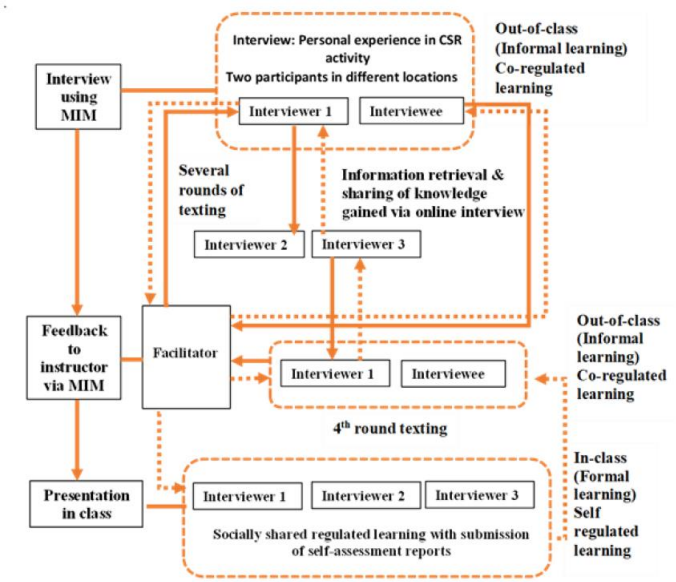

Fig. 3. The flow of interaction in case two (First CAR)

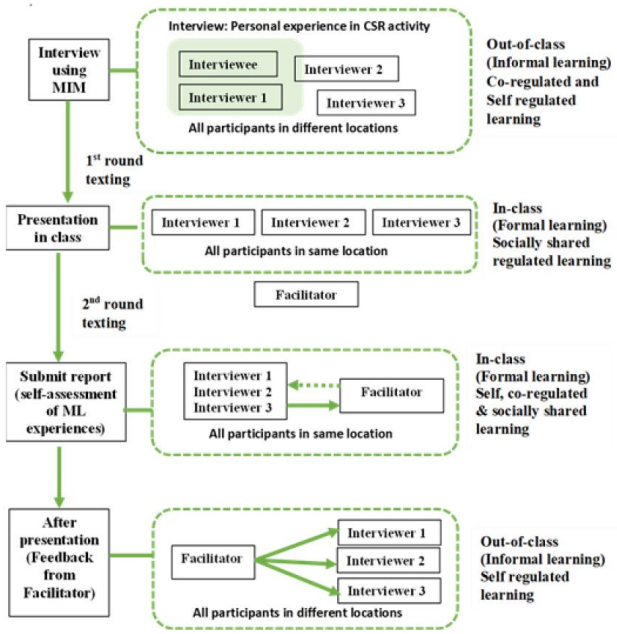

Fig. 4. The flow of interaction in case three (First CAR)

5.3. RQ.3: What are the factors influencing mobile learning in knowledge construction?

There are many factors that influence mobile learning, especially in tertiary education where collaborative and communicative discourse are necessary for pursuing knowledge. Interesting factors affecting students' learning experiences in mCSCL activities are discussed as follow:

5.3.1. Accountability in collaborative task

In their research examining the theoretical connections between mobile learning and SRL, Sha, Looi, Chen, and Zhang (2012) argued that due to ubiquity afforded by mobile technologies, learners needed to assume the responsibility of their own learning, more than other types of learning. These findings reinforced this linkage based on the active interactions that have emerged between students and instructor and among students. Students showed accountability to complete their own share of the work while assisting others. This sense of responsibility was strengthened with the perceived connectedness. Students demonstrated greater mutual engagement in their willingness and readiness to share and transfer knowledge and information when requests were made on their mobiles. They were more expressive and willing to ask for help and show appreciation when help was given. The reciprocal acknowledgement of the sharing and acquisition of knowledge enhanced learning outcomes. Interestingly, students suggested that performance in learning should embed active interaction that prevailed with the use of technologies. The request for sharing indirectly indicates that these learning materials are student-generated. The greater the collaboration and sharing with acknowledgement, the higher the sense of ownership to the content. As one student said, the sharing brought pride and showed the importance of one's work. The impact of the instilled ownership to the learning means that content is not a "copy and paste" work but a learning that requires "effort into reading" and to be adapted into "a good piece of shared work."

5.3.2. Students' commitment, integration and motivation in mobile learning

Consistent with the study by Shih, Chu, and Hwang (2011), positive changes in attitudes of the students have been observed. Shih et al. (2011) cited that students were more focused on the learning content presented on the mobile devices and was supported by evidence that students made efforts to read and interpret each other's work. A reflection of a higher level of commitment and motivation, the reading process is a crucial phase in turning "information into knowledge." When this occurs, students "understand the content and receive better understanding." Because technology enables students to engage in social interaction with significant others in cross-boundaries contexts, they regard such practical experiences as "consolidating their effort to the building up of knowledge." Hence, the learning is no longer perceived as "a piece of information" but knowledge which they can present confidently "without reading the note." To enhance learning to a higher level, a participating student retrieved an article relating to new information obtained from her conversation and came up with a summary to affirm her learning. Therefore, this new knowledge acquired can be based on the sharing of learning experiences.

5.3.3. Learning designs encompassing teachers, peers and community relationships

In their research on mobile learning design, Stanton and Ophoff (2013) suggested that teachers needed to have a basic understanding of the various characteristics of mobile learning and how they could best be used. The use of traditional user experience knowledge is therefore inadequate when learning is geared towards a more personalized mobile learning experience (Zou, Xie, & Wang, 2018). This sentiment surfaced when students in the study expressed frustration metaphorical with "tons of questions" but hesitant "to ask all those questions at the same time in the class." With mobile learning, students were more receptive and felt no need to "pile up questions" and would be "less hesitated" to ask "anytime and anywhere." Importantly, they firmly believed that for learning to have impact, "communication is a must" and that "changing the way things are done inside and outside class" was a key in this process. They sought changes in the teaching designs. Mobile learning strategy is thus a crucial factor attributing to effective learning and performance. Learning with technologies allow students to engage in authentic real-world learning and is considered a powerful learning strategy. Especially with the social impacts of mobile learning, students develop learning relationships with teachers, external learning partners and peers to enhance productive learning experiences. This understanding of the mobile learning process has been highlighted by one of the students that the instructor "did not want the class to just read through the books," instead "she wanted us to experience by our own self." This means mobilizing students to learn from the "outside world" is "more fun to have." The presence of others to promote learners' autonomy and creativity in learning activities is therefore essential to create a better path towards a more realistic approach to mobile learning.

5.3.4. Role of the learning facilitator

Interestingly, students envisaged changing role of instructor which deviated from its traditional knowledge of transfer "teaching" role to one that was multidirectional facilitation. This role however was not equated with lesser responsibility. Instead it involved greater accountability in terms of providing feedback, connecting and bridging knowledge gaps, motivating students to pursue learning challenges, and communicating for learning purposes. The close bonding with the students implied an opportunity for more personalized learning through mobile interaction. This change in role has been mentioned in the study by Schenke, van Driel, Geijsel, and Volman (2017) that narrowing the research and practice gap involved on how cross-professional collaboration was shaped. Good linkage between researchers and practitioners is needed to develop sound understanding. A good supporting evidence of the altered role was based on a student's reflection that frequent feedback from the instructor was productive and that he considered himself "making changes and approaching classmates for good input to the report." The open channel allowed students to interact with the instructor more frequently and easily either individually or in group. This effectively extended the hours of availability of the instructor, but this might not be the preference of all teaching staff, especially traditionalists.

These findings also affirmed the view of Schenke et al. (2017) that teachers in boundary crossing activities learnt to approach their teaching with a more inquiry-based attitude. They were able to incorporate new concepts in teaching and adopt methodological techniques for evaluation. Although there was a perceived decrease in teacher-regulation, students were given greater autonomy in the mobile learning process.

5.3.5. The boundary mechanisms and impacts of cross-boundary learning

Although the above 4 factors are based on empirical data, the fifth factor is derived from the theoretical model of cross-boundary learning by Akkerman and Bakker (2011). The boundary mechanism is constructed under the framework of identification, coordination, reflection and transformation. The students' empirical data based on their real-time experiences in cross-boundary learning are worth mentioning and should be included in this research theoretical model. Students envisioned wider learning boundaries with access to advance communication technologies. The sense of isolation as in an "island" or classroom was no longer a barrier with mobile learning. Empowered with the mobile tools, students were much more confident to explore new and authentic ways to amplify their learning. These phenomena have also been supported by the literatures.

Central to mobile learning designs and strategies, is that mobiles serve as boundary crossing tools allowing students to break through the "walls" enclosing the classroom into the third space (Kearney, Schuck, & Burden, 2010) Beside studies by Shen, Kuo, and Ly (2017) and Alsaadat (2017), research on the cross-boundary mechanisms is still limited. Specifically, cross-boundary mechanisms have received very little analytical attention. This findings on learning behaviors are significant as it fills the knowledge gaps in "evaluating learning performance or higher-order thinking" in cross-boundary mobile learning (Chang & Hwang, 2018).

5.3.5.1. Students' perspectives of the identification process

Although students have their own social network, it might not be good enough to support cross-boundary learning. Students realized that it was a challenging task to get connected with individuals who possessed the desired information for effective sharing. From the student perspective, the identification process was a robust active learning process comprising of three main processes namely, reaching out to, interacting with, and connecting to the experiences of the right people. Prior to this identification process, students expressed apprehension that they might not locate appropriate individuals. If they did, would they be granted the opportunity for sharing remained a question. As such, students tended to make cautious decisions as to whom they should approach to make good connections for their tasks. Locating better sources increases the chance to meet the task objective and help them "score well."

This flow of thought is significant in understanding the mobile learning process in the cross-boundary context. Students' high level of engagement was significantly linked to their desire to perform well. Crafting an optimal way to attain the right experiences is seen as a pre-determining factor to effective mobile learning. Perceived as an exploratory task, students also viewed the identification process as a 'Who and How approach' to find the significant others for a safe and stimulating engagement. Therefore, the prior process to identification includes careful decision making, setting the selection criteria and making efforts in the internal and external network sourcing for the desired significant others.

5.3.5.2. Students' perspectives of the co-ordination process

In the co-ordination stage, students' self-regulatory behaviors intensified as they started to focus on the outcomes of their interactions. At this phase, students sought ways to ensure effective collaboration by establishing appropriate ambiance to facilitate the question and answer session. Significantly, from the reflection of the students, they were

aware that the extent of the learning depended on how motivated the external learning partners saw the significant of the interaction. That was why, about a third of the students mentioned that it was important to introduce the purpose of the activity at the start of the interaction. With the understanding that the information provided was "not available in text or from classroom learning materials," students valued the sharing and transferring of knowledge from their learning partners. They engaged in active interaction to generate new content and this was part of the new knowledge creation process. Students began to reflect on the interactions leading to the internalization of the learning.

This insightful understanding allowed them to apply the new knowledge into the learning task. The evidence from the second CAR supported the fact that active sharing in cross-boundary learning motivated learning partners to develop reciprocal relationship. The findings showed that active engagement through questioning, discussing, and reflecting helped students to increase their understanding. When external learning partners became motivated, they were more willing to provide other assistance. Fig. 5 illustrates the co-ordination process in the cross-boundary learning.

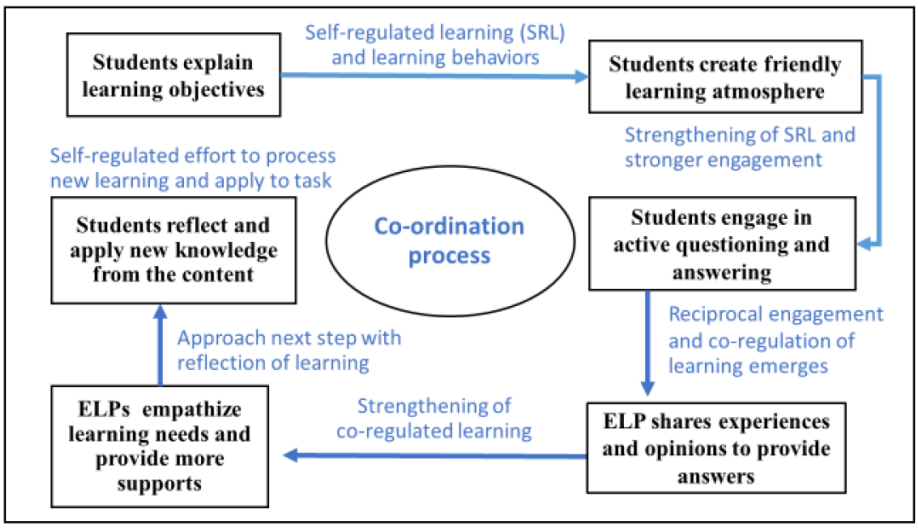

Fig. 5. Co-ordination process in cross-boundary mechanisms

5.3.5.3. Students' perspectives of the reflection process

The reflection process is the next important step in the construction of new knowledge. Students were more receptive to diverse perspectives and social experiences. Text messages were read with care and they became aware of multiple ways messages might be interpreted. Students generally perceived the interaction in positive manner. With the recorded text information, they were able to read and re-digest the information through reflective thinking. In fact, the takeaways were more than expected as they could go back over what was said in this format. Students realized that conversations made them "think a lot more" as well. This added benefit is vital in stimulating the metacognitive skills for the analyses, application and integration of the new knowledge into the learning task. As put forth by a student, "there are too many facts to be remembered but the easiest way is to talk and hear direct from others." Learning partners were able to indicate specific information relating to the topics of discussion. The keywords provided new directions for students to further explore concepts and discover an even greater sphere of learning

which if not "chatted" would remain unknown or of little interest. The directed learning behavior was strongly demonstrated in many of the reports submitted by the students. One student mentioned "just through books and network are not enough to really understand" and thus social learning allowed them to "learn a lot of things" and formed friendships and community for learning. These evidences strongly indicated that knowledge is information combined with experience, context, interpretation and reflection (Davenport & Prusak, 1998).

The interaction not only influenced students in terms of 'perspective taking' (Boland & Tenkasi, 1995), it also helped them to form new perspectives as reflected. Students became more critical in their thinking and looked beyond what was expected in the task. Apparently, they took a more neutral stand to problems and identified solutions based on rational thinking. This observation was clearly reflected in a student's remarks on how the different economic status quo of each nations affected development and influenced the mindsets of the people towards living and working. Ability of the students to categorize content and integrate their new learning to form new impression was worth mentioning because the interactions had enabled the visualization of the learning. The diversity of the interaction generated strong impressions and subsequently helped students to develop deep learning leading to the construction of new knowledge in a collaborative sense.

Therefore, in this reflection stage as shown in Fig. 6, students were indicated as going through the learning process of experiencing, reflecting, conceptualizing, and acting to create new experiences. Mutual understanding could be reached with greater effort from SRL after or during the exchanges and reflection of generated new perspective taking and the co-created new knowledge when applied to task. The active engagement would enhance interpersonal relationship.

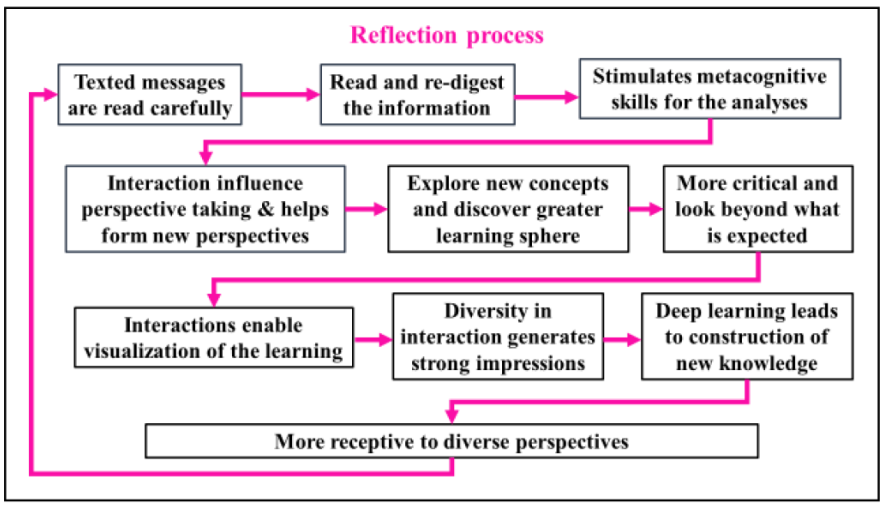

Fig. 6. Reflection process in cross-boundary mechanisms

5.3.5.4. Students' perspectives of the transformation process

The transformation process was not easily explained. The 'well-lighted house' and 'the bouquet of flowers' implied the removal of physical barriers where the bulk of knowledge housed and the diversity in the selection of social experiences respectively.

The transformation process could be witnessed based on the depth of self-reflection and assessment of the learning by the students. The ability of the students to make assessment of the new understanding and to generate better explanation signified the consolidation of the new knowledge acquired as visible as a repeating pattern in several of the transcripts. To understand the preferences of the people, students conducted more online research into area of interest. Reading articles on specific issues allowed students to refine their reasoning skills. As such, the knowledge shared and transferred from the collaborative mobile learning, motivate students to effectively and timely enhance the new knowledge co-creation process and subsequently, the quality of learning.

When students were able to connect themselves to the new learning, two interesting observations were made. A student decided to make a visit to the home country of the learning partner to witness the kind of lifestyle that she was introduced to. Another group of students also made a trip to the country to further their real-life exploration. This incidence shows that "transformation involves real dialogue and collaboration" between boundaries (Engeström, Engeström, & Kärkkäinen, 1995, p. 333). These two instances might reflect an emerging trend in learning. These examples show that knowledge acquired enable students to justify personal belief to increase their own capacity to take effective action (Alavi & Leidner, 1999). Students nowadays have greater opportunity to authentic learning and individually or in group. They are willing to explore into both space and physical boundaries that are better known to them via cross-boundary learning. Apparently, in the transformation stage, students might explore out of the comfort "mobile" zone for experiential learning. The understanding and reflection based on student learning experiences and behaviors have allowed the researcher to develop a transformation process that students are likely to go through. Fig. 7 depicts the transformation process in a cyclical flow based on students' experiences.

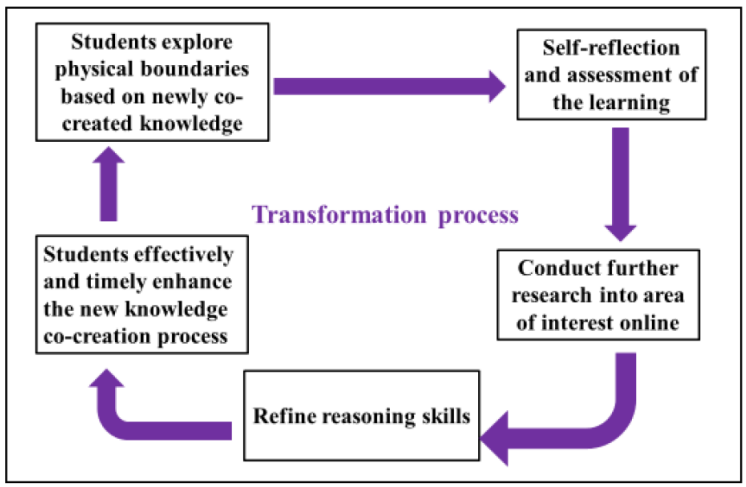

Fig. 7. Transformation process in boundary crossing mechanisms

5.4. RQ4: How does regulated learning facilitate the co-creation of new knowledge in mCSCL?

In an environment designed to stimulate socialization of learning activities through mobile devices, the learners find ways to self-regulate their learning activities. Once they are aware of the importance of sharing and seeking new insights in learning quality

(rather than just transfer of existing content), they become adept at co-creating new knowledge and understand how this can be applied to change future possibilities.

From the second CAR, students reflected on their mobile learning activity citing that "There was no table to divide us. We needed to talk to find out differences and similarities with the information I had obtained based on our texting" This remark signified the realization of the need to collaboratively built up their knowledge base and to reify one's understanding of learning experiences. Observing the paperless discussion process, another student cited that "as we discussed, we looked at the massages on our phones" and that "was all we needed". This further emphasized that "information was captured, stored and retrieved instantly". Students felt that they were able to discuss without any problem and that "the sharing and transfer of information were surprisingly not that difficult because of mutual needs".

Through the shared regulation process, group members could develop their motivation together. When students engaged in the handling process of the information, internalization took place. Reflecting on her interaction, one student moved on to evaluate the unstructured group data into categories that allowed effective sense making. This process ended with the gain of wisdom by the individual not just enhancing one's 'own learning' but also 'working with people in and outside' of the classroom. Another student remarked on the mutual sharing cited that "the mutual sharing of learning in class gave us the chance to talk to each other and we could select what we needed to complete the assignment". Students became more alerted and followed the interaction on the group Line for information. Revealed by a student that "from the group Line, my friends posted some interesting interviews and I asked their permission to use the information". The group Line regulated learning consensually. The regulatory processes were co-constructed in reciprocal interaction. As such, students seemingly were more receptive as they were keen to ask questions online. The group processing came with knowledge sharing and positive interdependency of each other contribution. As for other student, socially shared regulated learning not only co-created new knowledge but also helped developed better reading skill. In her contentment, the student said, "if I had not read my friends' work, I would not have understood what Baba and Nyonya meant". Students were satisfied with their learning outcomes. As put across by a student that "the texting and video calls on the mobiles were not that long but the interaction with friends and lecturer in class and on Line or WeChat were more intense because now I needed to put many ideas into the report". Another student also concluded that "this assignment was actually very different from other group works. This assignment, everyone took the role of the team leader. We must carry out the task by ourselves". This statement showed that the student was able to make comparison between mobile learning and traditional learning methods. She had a different view on the concepts of team and leadership in learning with each assuming a leading role in the socially shared regulated learning process. The mobile technology-based learning was considered a new teaching method that students needed to be engaged and performed to learn. It was not a simple and easy task but an assignment that needed one to take personal responsibility to explore and co-create new knowledge. To undertake this role, students needed to be "open-minded and try something new" as suggested by one student.

A metaphorical sense of cooking was used by a student to express her new knowledge co-creation experiences. She stated that "after talking with others and among ourselves, I could see a 'bigger picture'. It was like cooking Tom Yum Soup. We added more ingredients and created a new recipe with what we had. The end product was a very delicious homemade Tom-Yum soup and how spicy the soup depended what people told us". The depth or 'spiciness' of the learning as in the 'dish' came with the sharing and

adding of information that was told by others. The reflection showed that the social form of regulation was much more sophisticated than the other forms of regulation in that they required both individual and joint processes. The complexity, flexibility and extent of the learning sphere impacted the evolution of mobile learning and created a blurry line between formal and informal learning as indicated by the students. The findings indicated that students saw the value in knowledge co-creation and approved the trend towards greater authenticity in learning. These findings align well with the latest research showing social engagement and technologies are rapidly becoming important in innovative learning approaches (Ferguson, Coughlan, Egelandsdal, Gaved, Herodotou, Hillaire, Jones, Jowers, Kukulska-Hulme, McAndrew, Misiejuk, Ness, Rienties, Scanlon, Sharples, Wasson, Weller, & Whitelock, 2019). The influencing factors mentioned towards new knowledge co-creation from this research are as follows:

a) The design of the in and out of classroom learning activity
b) Degree of mutual engagement in cross-boundary learning
c) Willingness of the learning partners
d) Involvement of the learners
e) Degree of directed learning
f) Sharing and transfer of knowledge using mobiles
g) Role of facilitator in mobile learning activities
h) Value learners associated with mobile learning

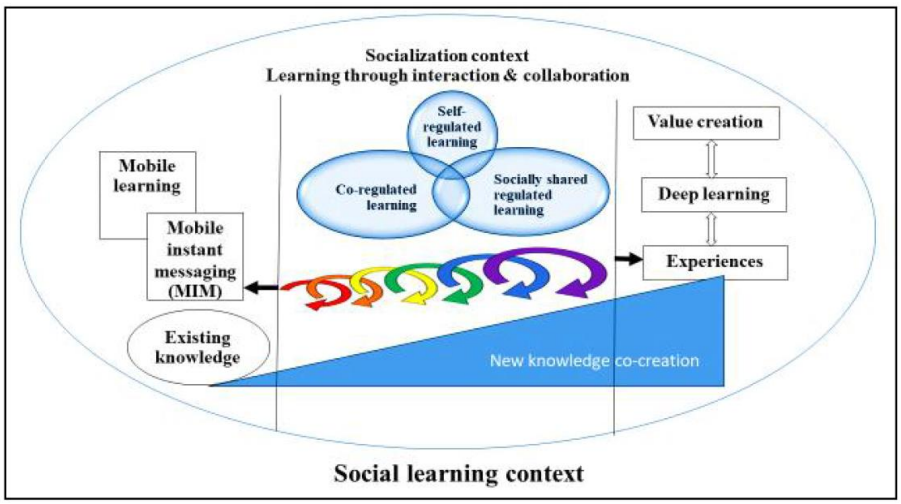

Fig. 8. The Strategic Co-creation of New Knowledge in mCSCL Model

6. Conceptual framework

Based on the significant findings of this research, the Strategic Co-creation of New Knowledge in mCSCL Model shown in Fig. 8, has been developed to further support our understanding of the mobile learning processes. As social learning takes place through a series of interactions, the socialization context is essential in the building up of new knowledge and greater opportunity for the co-creation of new knowledge. The regulatory

behaviors of students enhance learning experiences to allow deeper learning. The engagement in collaborative learning and efforts in constructing new knowledge further generate value in learning which signifies effective mobile learning in mCSCL environment. The details on how this model was developed and built is to be discussed in Lim and Shelley (2020).

7. Limitations

This study is limited by being a small number of students in a few classroom situations and in a restricted range of cultures and topics. Whilst there is no doubt mobiles make a difference to the learning experiences of these learners, more research in other situations, cultures and topics should add further credibility to the models and ideas raised in this research. In addition, subjective observations of people engaging with each other in social contexts are often criticized by quantitative researchers. However, this uncontrolled, unpredictable situational subjective interaction is the way we learn to deal with the unpredictability of human ecosystems. More studies in such subjective environments will assist us to understand more about how to bring some complex approaches into what we do as learning facilitators to enable better learning. This is especially important as instructors are often challenged to make discussions in the complex and rapidly changing world.

8. Recommendations

This study has re-conceptualized the mobile learning process from the students' perspective, opening many opportunities for instructors to further develop innovative learning activities. Envisaging the new perspective, instructors will benefit from reframing their own mindsets, by questioning themselves about what other important factors should be considered when conducting their classes.

The first recommendation from this study is that instructors create learning designs that encompass the knowledge from teachers, peers and communities of interest. The researchers also highly recommend instructors to consider the emotional and social implications in the development of student-generated content and the co-creation of new knowledge when assessing mobile learning performances. Importantly, instructors ought to be receptive to new learning outcomes.

The second recommendation is to consider how to apply these new influencing factors to reshape learning design and evaluation. Instructors are advised to explore creative and innovative learning designs to optimize the knowledge co-creation effort of participating learners. Learning activities should be designed to stimulate and sustain the proactive learning behaviors of students and particularly gear towards effective transformational learning to generate and co-create new knowledge. The criteria for assessment of content should be extended and incorporated with the cross-boundary mechanisms. The co-creation of new knowledge is value-added and crucial. It motivates students to engage in deeper learning, as indicated in the research findings. When the communicative learning tools enable the engagement of a wider audience in the learning process, perspective taking and making become context sensitive. This means instructors must allow students to critically assess their own learning performances and ensure they are given the opportunity to justify their work performance and reflect on their learning outcomes.

The third recommendation directs instructors towards the optimization of regulatory learning behaviors to improve the design of learning activities for students. As the findings have demonstrated the critical influence of SRL behaviors, instructors need to refocus on learning designs that optimize the regulatory learning behaviors of students. Instructors achieve better outcomes when they stimulate learning and encourage students to co-create new insights, rather than focusing on one-way transfer of existing knowledge. To do so, instructors can allow students to share and transfer knowledge via interaction and messaging. This in turn, increases mutual engagement and enhances effectiveness of SSRL to a greater impact on individual students. When social learning is embraced, it also helps to develop new learning culture of asking and helping (Shelley & Goodwin 2018). Instructors are therefore highly recommended to cultivate a new learning culture through proactive interaction to optimize the regulatory learning behaviors of their students.

9. Conclusions

This study demonstrates that mobile technology is an excellent way to stimulate the social co-creation of new knowledge. The use of mobiles can improve learning experience of students beyond the mere transfer of a few selected contents of the pre-defined curriculum and overcome physical constraints of the classroom. Well-designed mobile interactions, aligned with the desired learning outcomes, engage the participants in learning how to learn. Such social experiences enable them to be more productive in their career in this unpredictable and rapidly changing world. There might be discomfort and resistance from both teachers and students at the early stage of this new learning approach. However, when the learning facilitator highlights the reasons for the unfamiliar approach, the learners soon become comfortable and excited about this approach and the discomfort soon disappears. The implementation of the three recommendations above will enable learning facilitators to achieve enhanced learning outcomes, engage learners better, and improve their learning experiences.

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