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Long Paper

Use of Intelligent Agents to Facilitate Group Learner Participation in Collaborative mLearning

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Abstract

Purpose – Learning Management Systems (LMS) provide a platform for collaborative learning with features such as online group discussions. Grouping members together to participate in a group discussion does not guarantee their participation in the online discussion. However, the use of intelligent agents to facilitate group participation can motivate group members to participate in the online group discussions leading to improved levels of group knowledge construction. This paper discusses an experimental design for evaluating facilitated learner participation in online group discussions using intelligent agents.

Method – In our experimental design we use two treatment groups (turn taking and informative feedback group facilitations) and one control group. We compared the levels of group knowledge construction amongst the three groups.

Results – The results of the study show improved levels of group knowledge construction where the facilitations for participation were provided compared to where they were not provided.

Conclusion – The study concluded that facilitating collaborative mobile learning using intelligent agents improves the levels of group knowledge construction.

Recommendation – Thus, we recommend the use of intelligent agents in facilitating group participation and consequently improving the group knowledge construction in collaborative mobile learning environments.

Practical Implication – The study implies that intelligent agents are effective in collecting and analysing group processes leading to improved interactions which improve group knowledge construction.

Keywords – group knowledge construction, group participation, intelligent agent, collaborative Mlearning, Moodle

INTRODUCTION

Students enjoy collaborative learning by interacting with one another, where they see each other as additional educational resources (McLaren, 2014). According to Näykki (2014), interaction among learners in collaborative learning is the key element in learning. Group knowledge creation is a product of group interactions. Knowledge is created through interactions, as a joint undertaking during collaborative learning (Damşa, 2013). Collaborative learning requires that participants jointly construct knowledge and be aware of the group processes (Blake & Scanlon, 2012), such as exchanging ideas, viewpoints and arguments as students discuss a group problem (Mthembu & Mtshali, 2013). Knowledge construction itself is an outcome of collaborative learning (Shukor, Tasir, Van der Meijden, & Harun, 2014).

The discussion platforms in Learning Management Systems do not automatically support knowledge construction (Zingaro, 2012). Learners need to be encouraged to engage each other during collaborative learning in order to create new knowledge (Durairaj & Umar, 2014). According to Blake and Scanlon (2012), it is a collaboration requirement that participants become aware of the group processes when jointly constructing knowledge. They should identify the components of joint knowledge construction such as questioning, building common ground, establishing inter-subjective meanings, positioning actors in evolving roles, building knowledge collaboratively, and solving problems together. These features are important in supporting the learning process and need to be captured when designing collaborative systems.

There is much room for use of technology in collaborative learning (McLaren, 2014). Mobile devices such as mobile phones and various players (mp3, mp4 and mp5) have become so common with people and are more preferred than desktop computers, due to their unique features such as portability, adaptability, flexibility, intuitiveness, and comparatively cheap prices (El-Hussein & Cronje, 2010). The use of mobile phones as connected computing devices with a multitude of services has made their use to be beyond mere conversational devices (Ford & Leinonen, 2009). The traditional method of delivering learning content though lecturing only is being replaced with mixed delivery methods such as group discussions and peer reviews (Rocca, 2010), which are available in mobile devices. In their meta-analysis involving 164 published papers from 2003 to 2010, Wu et al., (2012) noted that the most researched topic in mobile learning was assessing the outcomes (product) of mobile learning rather than collaborative processes. Thus, a lot of research in m-learning has been driven by the capabilities of the mobile devices and the technical challenges, but little has been done on how meaningful and productive the mobile technology supports collaboration (Park, 2011).

Intelligent agents are good for incorporating learning theories into collaborative interactions and environments (Miao, Yu, Shen, & Tao, 2010). Due to their features, intelligent agents are suitable for collaborative learning to provide control over interaction and assessment for group members during group discussions (Looi, 2014).

This paper discusses the use of intelligent agents to provide pedagogical support for collaborative learning. There were two types of facilitation used to motivate and encourage learners to participate in online group discussions (i) turn taking and, (ii) informative feedback. The two facilitations were implemented using intelligent agents within the Moodle Learning Management System.

RESEARCH QUESTIONS

There were three research questions which guided this paper.

Research Question 1:

Which groups of learners (those using informative feedback facilitation or those without) achieve higher levels of group knowledge construction in collaborative m-learning group interaction processes?

Research Question 2:

Which groups of learners (those using turn taking facilitation or those without) achieve higher levels of group knowledge construction in collaborative m-learning group interaction processes?

Research Question 3:

Does informative feedback facilitation achieve higher levels of group knowledge construction than turn taking facilitation in collaborative m-learning group interaction processes?

LITERATURE REVIEW

Knowledge Construction

Knowledge construction is a mental act of both acquiring new knowledge and communicating existing knowledge and takes place when a learner disagrees with a partner's conception or identifies an error in his/her own thinking (Mthembu & Mtshali, 2013). Knowledge building in collaborative environments is made up of two major steps: internalization and externalization (Zufferey, Bodemer, Buder, & Hesse, 2010). Participants internalize the shared information into their mental schema which could lead to modification of the knowledge according to their experiences and prior knowledge (Zufferey et al., 2010). A conceptual change occurs when learners construct their own knowledge by modifying their conceptual framework (Chow & Treagust, 2013). Externalization involves sharing the knowledge with others (Zufferey et al., 2010). This is also referred to as 'knowledge co-construction' and involves high-level interactive processes where information is shared by pooling together different pieces of information from multiple sources (Näykki, 2014). New knowledge is created by students when they actively engage in construction of an external, shareable artefact that helps them to reflect and collaborate with others (Fessakis, Dimitracopoulou, & Palaiodimos, 2013).

Knowledge construction can be enhanced within group discussions and debates by encouraging constructive arguments (Zhu, 2012). Facilitation is instrumental in shaping a discussion and thus affecting the students' knowledge construction (Hew &Cheung, 2011). There is need to facilitate the learning experience through quality learner interaction and engagement (Song & McNary, 2011).

Group Learner Participation

Student participation in a group learning activity is critical to the success of collaborative learning (Liu, Wang, Liu, Wu, & Li, 2015). Bassani (2011) points out the need to actively promote participation in collaborative learning. There is need to design collaborative learning environments which encourage students to participate in shared knowledge-construction processes (Hämäläinen & Häkkinen, 2010). An effective discussion forum should actively promote student participation (Bassani, 2011), and provide student motivation by dealing with the danger of isolation and disconnection (Rovai, 2007). Students require guidance on how to interact (Ruiz-Primo, Briggs, Iverson, Talbot, & Shepard, 2011), and the facilitation of collaborative interaction leads to better and effective collaborative learning (Kim, Kim, Khera, & Getman, 2014).

For realization of successful collaborative learning, there is need for the instructor to closely monitor and provide feedback to students (Chen, 2007). The feedback provided during the learning process should not take charge of the learning process (Flórez& Sammons, 2013). Other than motivating the students, feedback facilitates a comfortable learning environment (Lee & Dashew, 2011). The instructor may encourage the students through questions, challenging their ideas and even formulating the idea to reach the conclusion (Ültanır, 2012). Being able to measure engagement (participation level) assists the instructor to provide appropriate feedback (Liu et al., 2015). For example, low engagement can be improved through encouraged participation. Any imbalance in student participation can be easily noted by monitoring the students' engagement in group activities. This not only facilitates for intervention by the instructor, but also allow for the students to gauge themselves and improve their engagement during collaborative learning (McLaren, 2014).

Equal participation is a key factor determining group's ability to solve problems, create ideas and make decisions (Woolley et al. 2010). One way of ensuring equal participation is by providing turn taking to group members. Turn taking is a collaboration rule which encourages opinion sharing and equal participation in group learning. The implementation of turn taking requires identifying a turn allocation technique for selecting the next participant when solving a group problem (Sidnell, 2010).

Agent-Based Facilitation for Group Learner Participation

Technology has been used to support interactions in collaborative learning (Isik and Saygili, 2015). Computer Supported Collaborative Learning focuses on the use of computer technology to enhance collaborative interactions (Magnisalis, Demetriadis, & Karakostas, 2011). Research in CSCL deals with the possible use of technology in social and construction elements of collaborative learning (Nkambou, Mizoguchi, & Bourdeau, 2010). The field of Artificial Intelligence has been used to enhance collaborative learning. Group formation algorithms in Machine learning (a field in Artificial Intelligence) have been used in automatic creation of discussion groups (Muuro, Oboko, & Wagacha, 2015). Intelligent agents (another area in Artificial Intelligence) have been used in developing information systems, especially Decision Support Systems (DSS) (Adla et al., 2012).

An intelligent agent is an autonomous computer software component which behaves as a human agent and works on behalf of a client (Udanor, 2011). The advantage of using mobile agents is that they adapt to the learning experience in order to meet the learner's requirements or to meet the changes in the learning environment (Henry & Sankaranarayanan, 2010). Agents are autonomous (they act independently), are interactive and communicative (they can send and receive messages with other agents), exist in some environment (which they can sense and act upon), and exhibit other properties such as adaptability, reactivity, proactively, mobility, responsively and rationality. Intelligent agents are good for incorporating learning theories into collaborative interactions and environments (Miao et al., 2010). Due to their features, computer agents are suitable for collaborative learning to provide control over interaction and assessment for group members (Looi, 2014). Intelligent agents have also been used to facilitate collaboration processes such as coordination, teacher intervention and group interaction (Erlin, Norazah, & Azizah, 2008). However, in collaborative learning agents need an addition of pedagogical functions to improve the learning experience for learners (Soliman & Guetl, 2010).

Design for facilitated Participation

Researchers continue to formulate instructional approaches to guide and improve collaboration processes and thus collaborative learning (De Wever, Van Keer, Schellens, & Valcke, 2010). This paper used two approaches to facilitate group participation namely informative feedback and turn-taking.

The type of feedback which was used for facilitating group participation (referred to as "participatory feedback") was meant to monitor student dormancy or dominance in the online discussions. When a student became dormant, an alert was sent to remind him or her of the need to continue participating in the discussion. When a student over-contributed, an alert to let him or her allow others to contribute was sent.

Turn taking is a round-robin strategy where each member was provided with a chance to contribute equally during group problem solving. Turn taking was meant to ensure that each member made a contribution to the discussion by having their ideas heard by providing information, questions or answers before any other member contributed twice (Skantze, Hjalmarsson, & Cortel, 2014). Turn taking was also meant to 'coerce' members to contribute to the discussion when their turn was provided and not to for a member to seem to "halt" the group discussion. Figure 1 shows the design for facilitating group participation using intelligent agents which was used in implementing a collaborative mobile application which was given to students for group discussions.

Each of the facilitations for group participation was implemented using an intelligent agent. The Turn Taking agent regulated the members' contributions in a discussion by allocating each member a time slot in a round robin approach. Thus, a member could not contribute twice before another member from the same group contributed to the discussion. The Informative Feedback agent monitored the participation level of each member in the group discussion. This agent supplied the group members with statistics about their level of participation where the passive members being encouraged to contribute and the dominant ones urged to pave way for their group members to contribute.

The two learning facilitations for group participation were developed as a plug-in to run on Modular Object-Oriented Dynamic Learning Environment (Moodle) Learning Management System. A Moodle component was developed for the two agents and the plug-in was incorporated into the Moodle mobile system for use by the students in their experiments. The agents were integrated into the system in order to collect and generate alternatives to allow students to use the facilities if and when provided.

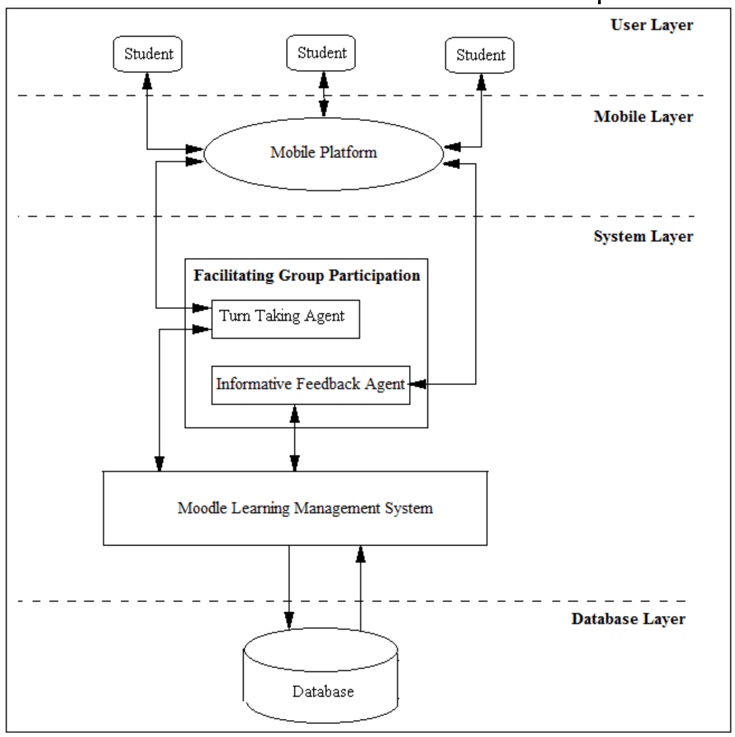

Figure 1. Design for facilitated Group Participation using Intelligent Agents

METHODOLOGY

We conducted a post-test only experimental study to investigate the effect of facilitated group participation on the level of group knowledge construction. A survey interview was also conducted at the end of the online discussions to give more insights into the requirements of the mobile application in order to improve its design.

The experimental study was done using students from a local university in Kenya. The students undertook a unit called "Data Structures and Algorithms" in a 14-week semester. According to Glassmeyer, Dibbs, and Jensen (2011), students get satisfied with group learning and get more benefits with online discussions when they are in groups of two to four members.

Research Design

The study used a post-test control group design with random assignment of the discussion groups. Multiple treatment design was used in order to deal with multiple available alternatives for facilitating group participation.

The study participants were given an explanation on how to participate in the experiment. They were assured that their participation towards the study would not be disclosed, and neither used in assessing them for the semester score. All the students were registered to the system so that they could access the learning material in form of posted lecture notes using their assigned usernames and passwords. The notes were available for downloading after the students were taught. This was done from the first week of the semester to the 7th week.

In the eighth week, the students participated in an online group discussion. They were first grouped in discussion groups of three members each. A total of 90 participants formed 30 discussion groups of three members each through self-selection. The participants were requested to form their own groups based on their familiarity of working with each other in previous class discussions. This study adopted an approach of two experimental groups and one control group adopted from (Oboko, 2012).The discussion groups were randomly assigned to the treatment groups (informative feedback, turn taking and control groups). Each treatment group was assigned 10 discussion groups. The experimental design showing the groups, treatments and observations for this study is shown in Table 1.

Table 1. Experimental Design showing groups, treatments and observations

Group	Treatment	Posttest
Experimental Group 1	X_1 – Use of turn taking	O_1
Experimental Group 2	X_2 – Use of informative feedback	O_2
Control Group		O_3

The difference among the treatment groups was due to the type of facilitated participation technique used by the students in each group during collaborative learning. Each of the facilitation was enabled /disabled depending on the specific needs of each treatment group.

Treatment 1: The members of this group used informative feedback for the facilitated group participation. The facility was also integrated within the collaborative m-learning application. This feedback was meant to motivate student to participate in the group problem solving.

Treatment 2: The members of this group used turn taking as the technique for facilitating group participation. This facility was incorporated within the mobile application to ensure equal participation by automatically assigning each participant a turn to contribute.

Treatment 3: This was the control group. The participants in this group were not required to use either the turn taking facilitation or the informative feedback support. They used the application which did not have any of the facilitations enabled.

Each discussion group was provided with an ill-structured group task to solve through the online group discussion posted within the collaborative m-learning application. Before the discussions started, the researcher informed the students of certain expectations of desired online behaviour such as no posting of personal insults or remarks, and no vulgarities in the discussions. Students made their contributions towards solving the collaborative task by sending text messages. All the contributions to the discussions were saved in a log file within the system's server. These logged messages identified the contributors and the discussion groups the participants belonged to. All the discussions were done concurrently for a period of one week.

A few students who were randomly selected to participate in an interview survey immediately after the online discussion was closed. The interview survey was conducted by the lead researcher and the responses from the selected students recorded for further analysis. Each participant was interviewed for 15 minutes. The survey aimed at getting more insights into the issues that were not captured during the experiments.

Validity of Results

The following measures were taken to ensure the validity of the results for this study:

a) Participants were given prior explanation about the usage of the application, and a brief guide on how to participate in online group discussion.
b) Participants were given random assignment of the online group discussions to the three treatment conditions.
c) Equal time allocated to each discussion group to solve the group task.
d) All discussions were conducted simultaneously.
e) Each of the online discussion group was not able to access or mingle with others during the discussion period.
f) The features to facilitate group participation were embedded within the collaborative m-learning prototype and students were not aware (or made aware) of the existence of those facilitations or their absence when solving the group problem.

Treatment Materials and Instruments

An ill-structured problem in "Data Structures and Algorithms" course was designed and used as the group task in the online group discussion. The ill-structured problem was developed through consultations with experts in the field of Data Structures and Algorithms.

A content analysis tool adopted from Van der Meijden (2005) was used in determining the level of knowledge construction for each group. Each of the categories in the Content Analysis Tool was assigned a ranked value based on its significance in the contribution to the process of group knowledge construction as indicated in Table 2. There were 14 values which were ranked from 0 to 13, with 0 ranked for contributions which do not relate to the discussion, and 13 assigned to the contributions with the highest contribution in knowledge construction. A criterion was developed and used for ranking the messages.

Table 2. Content Analysis Tool with ranked values

Cognitive: Asking Questions (Cognitive 1)		Example of use	Ranking Value
QTN-NXP	Asking Questions that do not require an explanation (fact or simple questions)	• How many outcomes do we get? • Is that the right answer?	7
*QTN-XP	Asking Questions that require an explanation (comprehension of elaboration)	• Why don't we choose another value for the pivot?	13
QTN-VER	Verification or asking for an agreement	• What are the leaves in your tree? • Is my explanation okay?	8
Cognitive: Giving Answers (Cognitive 2)			
ANS-NXP	Answering without explanation	• There are 3 types of nodes. • The main task is creating a tree.	6
*ANS-XP	Answering with explanation (using arguments or asking a counter-question)	• The information shows that…. • An expression tree is a binary tree because ….	12
Cognitive: Giving Information (Cognitive 3)			
INF-NELB	Giving information (idea or thought) without elaboration.	• Both trees are correct. • So far we have three similarities	4
*INF-ELB	Giving information (idea or thought) with elaboration.	• Let's now highlight the differences because…	10
INF-REF	Referring to earlier remark/information	• From your answer, it is true that …	5
INF-EVL	Evaluating the content (summarizing/ concluding)	• So, the conclusion is … • We have agreed that …	3
ACPT-NELB	Accepting contribution of another participant without elaboration.	• I agree. • You are correct.	2
*ACPT-ELB	Accepting contribution of another participant with elaboration.	• I agree with you because… • Yes, but you should specify the operands on the right and the left hand sides.	9
NACPT-NELB	Not accepting contribution of another participant without elaboration.	• I don't think that is the cause of the problem. • I don't think that is right.	1
*NACPT-ELB	Not accepting contribution of another participant with elaboration.	• That is not the reason because… • I don't agree with you because…	12
ANY-OTHR	Any other contribution not in any of the categories above. Will include contribution (question, answer or information) which do not relate to the topic being discussed.	• Where are you members? • When is the discussion ending?	0

NB: All the codes with (*) indicate high level cognitive contributions, thus ranked higher in knowledge construction

Data Analysis

There were two primary sources of data for this study: a) messages posted during the online group discussion, and b) data collected from the interview survey. The messages posted in the online discussion by the participants were stored in the system's server and were analysed using ANOVA. ANOVA was used to determine if there was a significant difference between the various treatment groups. The interview survey data was collected from the few randomly selected participants.

RESULTS

Analysis of the Posted Messages

A total of 364 messages were posted by 90 students who participated in the online group discussion. To facilitate analyses, the data (message posts) was exported to Excel. The data was then sorted using two columns (group ID to identify the group a participant belonged to, and then by Time Created to identify the time the message was posted and the sequence of the discussion). The posted messages were categorized into different knowledge level codes by two independent coders using the Content Analysis Tool in Table 2. The inter-rater agreement's Kappa value for the posted messages was 0.723. A value between 0.61 and 0.80 is a substantial agreement while one between 0.81 and 1.00 is almost perfect agreement (Landis & Koch, 1977). A third rater was involved in categorizing the messages where the two raters did not agree. In cases where two of the three coders did not agree, a consensus was reached by the three coders.

The average levels of knowledge construction for each group of three members were calculated using the assigned values for each category in Table 2. Those average levels of knowledge construction were used for further analysis in this experiment.

The results for the study are discussed based on the research questions.

Research Question 1: Which groups of learners (those using informative feedback facilitation or those without) achieve higher levels of group knowledge construction in collaborative m-learning group interaction processes?

Table 3 shows that the control group (1) registered a mean value of 6.91 and the mean for informative feedback group (2) was 8.36. The level of knowledge construction for the control group ranges from 5.24 to 8.30 compared to the ones for informative feedback group which ranged from 7.16 to 10.00. The Tukey post hoc test revealed that the level of knowledge construction was statistically significantly higher when using the facilitations for informative feedback (at a level of 8.36 ± 0.32, $p = 0.003$) compared to the control group (neither turn taking nor informative feedback) (at a level of 6.90 ± 0.30).

Table 3. Means and variances for facilitated group participation

	N	Mean (*M*)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	10	6.91	0.94	0.30	6.23	7.58	5.24	8.30
2	10	8.36	1.00	0.32	7.65	9.07	7.16	10.00
3	10	8.56	0.67	0.21	8.08	9.03	7.88	9.83
Total	30	7.94	1.13	0.20	7.52	8.36	5.24	10.00

The results shows further a significant difference in the level of knowledge construction between the control group (1) and the informative feedback group (2) (p = 0.003) (see Table 4).

Table 4. Multiple Comparisons for the treatment groups

(I) Facilitation	(J) Facilitation	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-1.45*	0.39	0.003	-2.43	-0.48
	3	-1.65*	0.39	0.001	-2.63	-0.67
2	1	1.45*	0.39	0.003	0.48	2.43
	3	-0.20	0.39	0.871	-1.17	0.78
3	1	1.65*	0.39	0.001	0.67	2.63
	2	0.20	0.39	0.871	-0.78	1.17

**The mean difference is significant at the 0.05 level.*

Research Question 2: Which groups of learners (those using turn taking facilitation or those without) achieve higher levels of group knowledge construction in collaborative m-learning group interaction processes?

Table 3 shows that the turn taking group registered a mean value of 8.56for group knowledge construction and the mean for the control group was 6.91. The level of knowledge construction for the control group ranges from 5.24 to 8.30 compared to the ones for turn taking group ranges from 7.88 to 9.83. According to Table 4, there exist a significant difference between the control group and the turn taking group (p = 0.001).

Research Question 3: Does informative feedback facilitation achieve higher levels of group knowledge construction than turn taking facilitation in collaborative m-learning group interaction processes?

The mean level of knowledge construction for turn taking group (M = 8.56) was slightly higher than the one for informative feedback (M = 8.36). However, there is no significant differences between the turn taking group and the informative feedback group (*p* = 0.871).

Analysis of the Survey Interview

Five (5) participants were randomly selected to take part in the survey interview. Table 6 summarizes the responses from the participants. 80% of the respondents (4 out of 5) were comfortable with their own selection of groups to belong to. From Table 6, some members suggested that some kind of motivation, such as data bundles, would have assisted in improving their contributions. Interesting suggestions were given on how to improve the system. For example, adding some graphics on user interface and improving the speed of access.

Table 6. Sample responses from the survey

Themes	Cited Examples
Group Selection	I felt comfortable working in the self-assigned groups made of people I am used to
Improving the Interface	The application can be improved by adding some more graphical appearance need to be added to the interface
Motivation	We should have been provided with data bundles when the Wi-Fi was not available

DISCUSSION

The intention of this experiment was to show how an intelligent based mobile learning application could help learners to participate in solving group problems. This discussion is based on the research questions

Research Question 1

The results show that mean value for group knowledge was higher for the informative feedback (M = 8.36) than the control group (M = 6.91). Also a significant difference in the level of group knowledge construction was noted between the group using the informative feedback facilitation and the group where the facility was disabled (p = 0.003). The high levels of group knowledge construction could have been due to the active participation by the members in that group. This is due to the fact that participants were reminded of their duty to contribute in the online mobile discussion if they became passive. This greatly improved on their level of participation, and consequently higher levels of knowledge construction. While this might not have a direct impact on their improvement on the group level of knowledge construction, the limitation by other participants not to dominate the discussion could have 'forced' the dormant ones to contribute to the discussion rather than stalling the discussion. The contribution of the 'seemed dormant ones' could have ended up in improving the level of group knowledge construction through injection of new ideas into the discussion.

Research Question 2

The participants in the control group attained lower mean values for the group knowledge construction (6.91) than those in the turn taking group (8.56). A significant difference exist in the two groups (p = 0.001). With each participant provided with a 'time slot' to contribute towards the discussion, each member was determined to ensure that he/she did not delay the online discussion. No member in the turn taking group would have allowed the discussion to fail based on his/her reluctance to contribute. Again, different ideas from the not so active members and which could have been seen as irrelevant, contributed to an increase in the level of knowledge construction.

Research Question 3

The results show that the two facilitations (informative feedback group and turn taking group) were not significantly different (p = 0.871). However, turn taking group (M = 8.56) had a higher mean value for group knowledge construction than informative feedback group (M = 8.36). This could be due to the fact that informative feedback was not as strict as turn taking facilitation in 'forcing' the student to participate. With turn taking a discussion could not continue unless the participants contributed in a round robin technique or pass the turn, unlike informative feedback where a discussion could continue even if a participant delayed in contributing for a while.

The interview survey results indicated the need to make further consideration in the design and approach of improving the collaborative mLearning application. This was an important contribution from direct users of the system.

CONCLUSIONS AND RECOMMENDATIONS

The research objective was to investigate the effect of facilitated group participation on the level of group knowledge construction in collaborative m-Learning group interaction processes. The analysis of the relationships between the independent variable for facilitating group participation (with two levels – informative feedback and turn taking) and the dependent variable knowledge construction showed evidence of what might make mobile learning management systems to be more helpful to the learners. The successful implementation of facilitations for group participation using intelligent agents in Moodle Learning Management systems suggest that collaborative mobile learning can be improved in terms of group participation and consequently improving group knowledge construction. From the study, it can be concluded that facilitated group participation improves the level of group knowledge construction. The use of both turn taking and informative feedback facilities resulted to improved levels of knowledge construction.

The responses from the few individuals who participated in the interview survey were important for the improvement of the design of the mobile application.

IMPLICATIONS

The use of intelligent agents is effective in collecting and analysing the group collaboration processes. The implication of this study on mobile learning is that learners will gain more from the use of this application resulting from improved outcomes.

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