The Evaluation of mLearning Implementation Model for English Language Learning via Fuzzy Delphi Method

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ABSTRACT

This paper introduces Fuzzy Delphi method as an educational tool to evaluate a technology-mediated education implementation model as part of a larger study. Specifically, the aim of the present study is to evaluate a mLearning implementation model as learning support for undergraduate students in formal language learning which was developed by the authors prior to this study. The study adopted the Fuzzy Delphi method to evaluate the model. Overall, from the findings presented in this paper, as the defuzzification values for all items in the questionnaire exceeded the minimum value of 33.6, the findings conclusively suggest that the participants have consensually agreed to all four aspects of evaluation of the model: 1) suitability of the elements (learning activities), 2) domain classification of the learning activities, 3) relationships among the learning activities, and 4) suitability of the model in teaching and learning activities in assisting students to fulfill their language learning needs and course outcomes. Thus, according to the participants or experts of the study, based on these aspects, the model is suitable to serve as a guide in the implementation of mLearning as learning support for undergraduate formal English language learning for *Professional and Communication Skills* course. The findings not only serve to introduce mLearning implementation model for language learning but also contribute to how the Fuzzy Delphi method could innovate assessment and evaluation of technology aided learning initiatives like mLearning.

Keywords: Assessment, English language learning, Fuzzy Delphi, Interpretive Structural Modelling, mLearning, mLearning model, undergraduate

INTRODUCTION

In the instruction of undergraduate language subjects, it is a major challenge for lecturers to provide meaningful language exposure to as many individual students as possible to develop their language competence, due to constraints as large class enrolments, but with limited time allotted for formal language classes. To add to the odds, most formal language instructions are still confined to the traditional drill and exercise principles. Mobile learning (mLearning) in language learning can be generally defined as a learning platform which is assisted by mobile devices and technologies which serve to facilitate social interaction ubiquitously in assisting learners to achieve their learning goals. Previous studies have supported the positive implication on students' language learning. For instance, Cavus and Ibrahim (2009) developed MOLT (mobile learning tool) and found that students were motivated in learning vocabulary through short message service (SMS) over their mobile device. Another study argued that the use of multimedia mediated through mobile devices successfully improved students' language skills (Saran, Cagiltay, & Seferoglu, 2008). In this study, mLearning was employed as a complementary tool to formal learning but the term 'to augment classroom learning' was more preferred (Quinn, 2011; Terras & Ramsay, 2012). In setting the perspective, classroom activities could be extended beyond the classroom anytime and anywhere, thus, allowing more opportunities for students to fulfill their learning goals according to their own pace.

The general aim of this study is to investigate how mLearning could be sustainably employed through the development of mLearning implementation model for an undergraduate English Language communication course. In this study, mLearning is defined as a set of learning activities via interaction, mediated through mobile technologies to augment language learning in assisting undergraduate language learners to achieve both target needs and language competency needs. The definition takes into account interaction as learning approach for language learning and language activities as an element of the model. The paper which is part of a larger study specifically presents the outcome of the evaluation of the English language mLearning implementation model (refer to Figure 1) (Abdullah, Siraj, & Hussin, 2014).

LITERATURE REVIEW

Past studies in mLearning have mainly focused on mobile devices, either in digital functions of mobile devices (Forehand, Miller, & Carter, 2017; Jackson, 2015), effectiveness of mobile devices in preparation of learning activities (Burton et al., 2015; Tseng, Tang & Morris, 2016; Vahey & Crawford, 2002), or mobile computer based project (Burke, Colter, Little, & Riehl, 2005). In Malaysia, aligned with the current mobile technology trend, the National Higher Education Strategic Plan (NHESP) has listed mLearning as one of the 23 Critical Agenda Projects (CAP), which is described as learning through enhanced portable technologies

such as mobiles and tablets (Pelan Strategik Pengajian Tinggi Negara [PSPTN], 2013). The country's support for mLearning through CAPs project and enhanced by the high degree of mobile communication device penetration in the country, especially among the present generation provides an ideal platform for mLearning opportunities. The Malaysian Communications and Multimedia Commission (2017) reported that for the first quarter of the year 2017, the mobile-cellular penetration was at 134 units for every 100 inhabitants, with a whopping 30.6 million units countrywide. However, despite the supporting factors above, mLearning is still at its infancy in Malaysia and research studies are critically needed in the area of mobile assisted education (Embi & Nordin, 2013). The main factor contributing to the slow pace in adoption of mLearning in this country despite the high accessibility to technology could be due to the scarcity of research studies in mLearning implementation areas. Most of the mLearning research for education in Malaysia to date has largely concentrated on perceptions (Hashim, Ahmad, Fatimah, & Rohiza, 2010), learners' satisfaction (Ismail, Gunasegaran, Koh, & Idrus, 2010), awareness (Alzaza & Yaakub, 2011), readiness (Ismail, Bokhare, Azizan, & Azman, 2013), learners' motivation (Narayanansamy & Ismail, 2012), and factors affecting mLearning acceptance (Yadegaridehkordi, Iahad, & Baloch, 2013). In order to take full advantage of mLearning in effective education delivery, research initiatives need to progress beyond investigating perceptions, readiness, or attitudes of the present learners towards mLearning. It is undoubted that studies in these areas are useful, but since past studies have abundantly reported on positive acceptance towards mLearning adoption (Embi & Nordin, 2013), further studies in mLearning implementation should be the next initiative.

Local studies which have contributed to implementation of mLearning can also be found though limited to specific context. For instance, an investigation on usability guidelines for designing mLearning portal was carried out by Seong (2006), who proposed three categories of usability and 10 usability guidelines for highly efficacious, user friendly and usable mobile interface. In another study, Shuib (2009) proposed a mLearning curriculum design for Malaysian secondary schools which he designed for History lessons. These studies have described the examples on practical implementation of mLearning. However, the studies were conducted either in adoption of mLearning in techno centric view or mLearning as a learning content delivery medium. Although it has been found to be useful, with the path taken by these studies, there is a wide gap in mLearning studies in the context of mLearning as a learning solution, for example as support to a learning problem, which conventional learning is unable to resolve. The argument is that mLearning as a solution or as support to a learning problem could be more sustainable in its adoption, instead of becoming a learning

replacement to conventional learning. Consistently, Koller, Harvey and Magnotta (2008) stated that one of the main features of technology-based education is the emphasis on learning solutions and learning results as it is contextual and accessible to learners, especially whenever it is needed. Unfortunately, in the studies of mLearning in language learning, most of these studies have often focused on formal learning contexts where mobile devices are primarily regarded as learning content delivery media (Kukulska-Hulme & Shield, 2008). An example is an investigation on design and development of a collaborative mLearning module (DeWitt & Siraj, 2010), which addressed Malaysian secondary school learners' needs of the use of technology in science learning. Another pertinent point would be that findings at secondary school level would not be appropriate in the design and implementation of mLearning at tertiary level. This is because the level of sophistication between students at secondary and tertiary level is different due to the gap in cognitive levels. The education structure of secondary level is designed to general knowledge and skills to prepare students for higher education while tertiary education system is tasked to prepare students with advanced and specific hard and soft skills for the job environment. Thus, to fill the gap in mLearning implementation studies, focusing on the idea of mLearning as a learning solution in the form of learning support to help students in their language learning needs, the mLearning implementation model for undergraduate English Language learning was developed in this study. This paper describes the study at the evaluation phase in validating whether the mLearning model of the study can be a suitable guide in implementing mLearning as learning support for undergraduate students in formal language learning.

Overview and Interpretation of the Model

Although the paper focusses on the study at the evaluation phase, it is pertinent to describe the interpretation of the model developed through the larger study to facilitate the base for discussion on the evaluation. With reference to Figure 1, the model was developed for the *Professional Communication Skills* course (PCS), which is a compulsory undergraduate English for Specific Purpose (ESP) course of a private tertiary engineering institution. The model consists of 24 learning activities, which is an integration of mostly informal mLearning activities and formal learning activities. Based on the findings of the larger study, the elaboration of each learning activity is given as follows:

1. *Attend in-class lectures on effective communication*

   The experts consensually agree that this learning activity has to be included as physical face-to-face guidance from the lecturer.

2. *Access and listen to lectures about effective communication on podcasts through mobile devices*

   In this learning activity, students are required to download in-class lectures on effective communication in the form of audio or audio-video formats to either listen or watch for information and reinforcement of learning.

3. *Search and browse for information on effective communication, language competence, and technical use of devices through mobile devices*

   This learning activity involves students' initiatives to obtain supportive content and information for self or collaborative learning process to gain communication skills, improve language competence or get the best practices in technical mobile device use.

4. *Listening to or reading online micro information on effective communication, competence (grammar) or technical use of mobile tools and devices through 'push' technology via mobile devices*

   This learning activity serves to complement learning activity 3. The difference between these learning activities is that learning activity 4 contains small learning content packages regulated by the lecturer or by the assigned content provider to push these learning packages from time to time to students through their mobile devices.

5. *Develop mobile tags for information and knowledge on communication, language competence, and technical use of mobile devices via QR code or social bookmarking*

   This activity is a collaborative effort among students to share information and knowledge through mobile tagging. QR (quick response) code or social bookmarking such as *Twitter* is a form of a mobile tag which enables students to develop and store information easily.

6. *Record and upload presentations to elicit comments from lecturers and peers via mobile devices*

   This activity represents the main learning activity to aid students' effective learning output for the language communication course. Students can record trial presentations to be shared with other students and the lecturer to elicit comments to improve their presentation skills before being evaluated.

7. *Video conferencing with other students and/or the lecturer via mobile devices to improve communicative and competence skills*

   This learning activity involves scheduled video conferencing among students or between students and the lecturer.
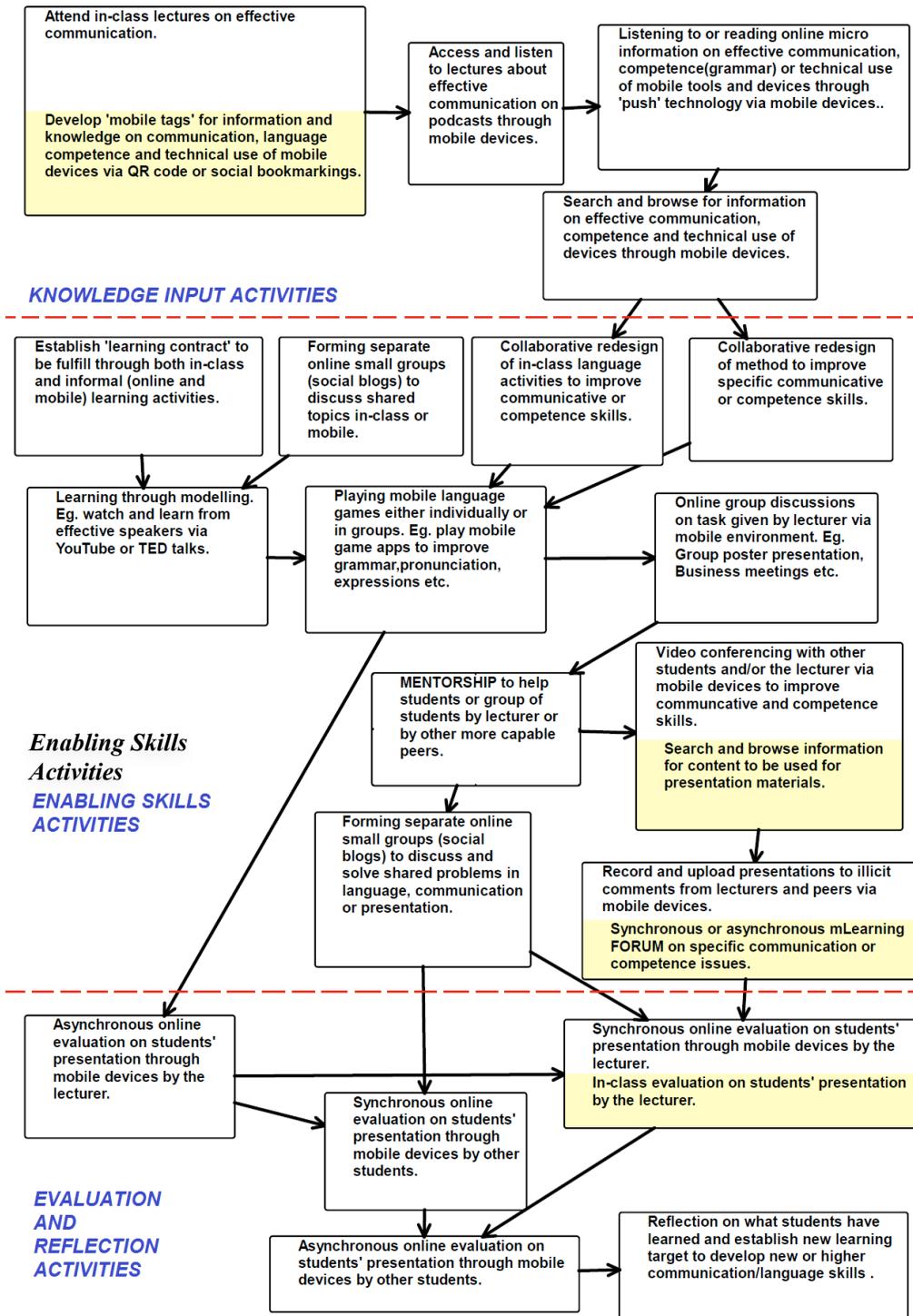
KNOWLEDGE INPUT ACTIVITIES

Attend in-class lectures on effective communication.

Develop 'mobile tags' for information and knowledge on communication, language competence and technical use of mobile devices via QR code or social bookmarkings.

Access and listen to lectures about effective communication on podcasts through mobile devices.

Listening to or reading online micro information on effective communication, competence(grammar) or technical use of mobile tools and devices through 'push' technology via mobile devices..

Search and browse for information on effective communication, competence and technical use of devices through mobile devices.

Establish 'learning contract' to be fulfill through both in-class and informal (online and mobile) learning activities.

Forming separate online small groups (social blogs) to discuss shared topics in-class or mobile.

Collaborative redesign of in-class language activities to improve communicative or competence skills.

Collaborative redesign of method to improve specific communicative or competence skills.

Learning through modelling. Eg. watch and learn from effective speakers via YouTube or TED talks.

Playing mobile language games either individually or in groups. Eg. play mobile game apps to improve grammar,pronunciation, expressions etc.

Online group discussions on task given by lecturer via mobile environment. Eg. Group poster presentation, Business meetings etc.

Enabling Skills Activities

ENABLING SKILLS ACTIVITIES

MENTORSHIP to help students or group of students by lecturer or by other more capable peers.

Video conferencing with other students and/or the lecturer via mobile devices to improve communcative and competence skills.

Search and browse information for content to be used for presentation materials.

Forming separate online small groups (social blogs) to discuss and solve shared problems in language, communication or presentation.

Record and upload presentations to illicit comments from lecturers and peers via mobile devices.

Synchronous or asynchronous mLearning FORUM on specific communication or competence issues.

Asynchronous online evaluation on students' presentation through mobile devices by the lecturer.

Synchronous online evaluation on students' presentation through mobile devices by other students.

Synchronous online evaluation on students' presentation through mobile devices by the lecturer.

In-class evaluation on students' presentation by the lecturer.

EVALUATION AND REFLECTION ACTIVITIES

Asynchronous online evaluation on students' presentation through mobile devices by other students.

Reflection on what students have learned and establish new learning target to develop new or higher communication/language skills .

Figure 1. Interpretive Structural Modeling (ISM) based mLearning Implementation Model of Undergraduate English Language Learning for *Professional and Communication Skills* course (Abdullah, Siraj, & Hussin, 2014)

8. *Online group discussions on tasks given by lecturer via mobile environment, for example group poster presentation, business meetings*

    Online group discussion opens up avenues for students to engage themselves in discussions on tasks or assignments given by the lecturer through mobile devices.

9. *Establish learning contract to be fulfilled through both in-class and informal (online and mobile) learning activities*

    Although mLearning postulates learner-centered learning, a complete guide assisted by the course instructor or the lecturer is needed to regulate learners' learning process in the mobile context to achieve their targeted learning goals more effectively. Learning contracts can be developed and proposed by the students, assisted by the lecturer.

10. *Forming separate online small groups (social blogs) to discuss shared topics in-class or mobile*

    As mLearning thrives on social and collaborative learning, this learning activity is proposed for students' collaborative knowledge construction through information sharing both in the physical and mobile environment.

11. *Forming separate online small groups (social blogs) to discuss and solve shared*

problems in language, communication skills, or presentation

This learning activity assists students in overcoming problems in language, communication, or presentation with the help of lecturer or more capable peers.

12. *Mentorship to help students or group of students by lecturer or by other more capable peers.*

    This learning activity facilitates collaborative learning through scaffolding to assist students who are unable to achieve learning targets or overcome learning shortcomings on their own (Vygotsky, 1978, p. 86).

13. *Synchronous or asynchronous mLearning forum on specific communication or language competence issues.*

    Synchronous forum session involves prescheduled slots where interested students may log in to an online forum scheduled at a specific time to discuss a particular topic. Asynchronous forum is a continuous forum similar to a blog where students can log in at any time to participate in discussions.

14. *Collaborative redesign of in-class language activities to improve communicative or competence skills*

    This learning activity allows students to collaborate and modify their in-class language activities using their mobile

devices to improve their communication or competence in a more motivating way.

15. *Collaborative redesign of method to improve specific communicative or competence skills*

Similar to learning activity 14, students collaboratively modify ways to improve their communicative or competence skills using their mobile devices. With this learning activity, students are able to record a short video presentation of their own topic of interest and upload it online to elicit comments from other students and the lecturer via blogs or other social applications.

16. *Playing mobile language games individually or in groups, for example playing mobile game apps to improve grammar, pronunciation, expressions*

Experts believe this activity needs to be considered as part of students' learning experience, as long as careful selection of mobile games is in place. The lecturer may involve students in selection of games application to be downloaded on their mobile devices to aid their learning process.

17. *Learning through modeling, for example, watch and learn from effective speakers via YouTube or TED talk*

Most experts view this learning activity as necessary to be considered as part of students' learning experience where

students learn through good examples. For instance, students can learn quickly through short videos on the difference between conducting persuasive talks for general topics and technical ones.

18. *Search and browse information for content to be used for presentation materials*

This learning activity involves students searching and browsing the Internet for input for their presentation, either in the form of content or supporting effects to enhance the quality of their presentation slides such as background slides, slide transitions, latest statistical displays and others.

19. *Synchronous online evaluation on students' presentation through mobile devices by the lecturer*

This learning activity involves evaluation of students' learning output (for example, poster presentation) by the lecturer based on students' live presentation through social networks such as Skype or face-time video calls.

20. *Synchronous online evaluation on students' presentation through mobile devices by other students*

This learning activity is similar to learning activity 19 but the evaluation is conducted by the students. Students can be notified through 'push' technology to log in at the specified time of presentation and evaluate the presentation.

21. Asynchronous online evaluation on students' presentation through mobile devices by the lecturer

The experts view this type of evaluation as a continuous assessment on students' work, thus providing a more thorough assessment as the lecturer can repeatedly refer to the videos for any strength or weaknesses of the presentations which may be overlooked before finalising the evaluation marks.

22. Asynchronous online evaluation on students' presentation through mobile devices by other students

Similar to learning activity 21, students' learning output can be evaluated online by students, either in the classroom or through mobile devices.

23. In-class evaluation on students' presentation by the lecturer

Similar to learning activity 1, the experts view this learning activity to be included as institutional validity for formal education.

24. Reflection on what students have learned and establish new learning target to develop new or higher language communication skills

This learning activity is where students reflect upon what they have already achieved in their learning goals at a certain stage or stages. This helps students to chart their learning achievement to improve skills and develop new learning targets parallel to the course outcomes.

Based on the model in Figure 1, the learning activities are connected to each other in a hierarchical manner based on pair wise technique. As suggested by the participants' input, the final model is divided into three sections or domains: knowledge input activities, enabling skills activities, and evaluation and reflection activities. Knowledge input activities that consist of learning activities 1 to 5 are activities that aid students in obtaining the necessary background information and knowledge about effective communication skills. However, knowledge input is not merely about delivery of content. In its early years, mLearning was adopted as a medium for content delivery (Kukulska-Hulme & Shield, 2008), but Quinn (2011) argued that the value of mLearning is learning which is facilitated through dynamic social interaction and this advantage needs to be exploited where learners can interact with other learners or resources. Through the concept of seamless learning anytime and anywhere, not only do learners access learning free from the boundaries of time and space, more importantly, they are able to reach out to other people and resources when it is needed most. This is the main capability of mLearning which supersedes other technology-based learning.

In complementing tthis concept, activities 9 and 10 promote establishment of communication among learners through online social blogs and learning contracts

as the initial platform for subsequent social learning processes. The enabling skills activities (learning activities 6 to 20) are the most important activities that the students engaged in to develop their communication skills through formal learning and mLearning. The evaluation and reflection skills activities (learning activities 19 to 24) are sets of activities to evaluate the students' language communication skills and for them to reflect upon their acquired skills - to further improve their skills or to develop new skills. The three domains are interconnected through their respective learning activities to form a holistic mLearning implementation model. For example, language activities 8, 16, and 17 rely on the conduct of activities 9 and 10. Language activities which are clustered in shared boxes (such as activities 1 and 5, 7 and 18, 6 and 13, and 19 and 23) suggest that these activities should be conducted in any sequence or concurrently and can complement each other).

METHODS

Fuzzy Delphi method is adopted for the evaluation of the model (refer to Figure 1) in this study because it is an established decision-making tool. Since evaluation of the model involves decision-making, the method is adopted. Another reason is that the method relies on experts' opinions in making decisions. Since the model has been developed using experts' views, it is compatible to use a panel of experts to evaluate the model too. Besides, Fuzzy Delphi method has also been used for

evaluation purposes in past studies, although it is widely used for planning, projections, decision-makings, and development. For example, the technique has been used in evaluating hazardous waste transportation firms (Gumus, 2009), evaluating battle tanks (Cheng & Lin, 2002), evaluating software development projects (Buyukozkan & Ruan, 2008), and evaluating public transport system (Hsu, 1999). In education, the method has been applied too. For example, Tarmudi, Anas Muhiddin, Rossdy and Tamsin (2016) applied Fuzzy Delphi in evaluating teaching effectiveness based on students' perspective. The authors reported that the method was very useful in dealing with the complexity of choosing the right teaching methods by lecturers.

In terms of the sample of the study, as the study applies the modified Fuzzy Delphi method, a panel of experts was chosen through purposive sampling to evaluate the model. A total of 48 experts were selected to evaluate and validate the model. In Delphi method, the most important step is the selection of experts as it affects the quality of the result of the study (Jacobs, 1996; Taylor & Judd, 1989). However, there is no standard criterion in the technique in the selection of experts (Kaplan, 1971). Thus, in setting the criteria for expert selection for a specific study, Pill (1971) and Oh (1974) stated that the experts should have some background or experience in the related field of study, be able to contribute opinions to the needs of the study, and be willing to revise their initial judgment to reach consensus among experts. Consistent with this,

Delbecq, Van de Ven and Gustafson (1975) proposed that qualified subjects for a Delphi study should consist of three groups: 1) the top management who uses the outcomes of the Delphi study, 2) professional individuals as staff members and supporting team, and 3) targeted individuals whose judgment are being elicited. In this study, based on the above criteria, the evaluation was conducted on mainly language instructors such as teachers or lecturers who also have experience in using technology in education. With regard to the numbers of experts for the study, the literature has yet to reach a consensus (Hsu & Sandford, 2007). For instance, past researchers proposed between 10 to 15 experts (Adler & Ziglio, 1996; Delbecq et al., 1975) as optimal in a Delphi study but some argue that 10 to 50 respondents are needed to facilitate the study (Witkin & Altschul, 1995). However, Ludwig (1994) explains that the number of experts used should represent a pooling of judgments and the capability of the research team in processing information. In this study, the researchers employed 48 respondents to form the evaluation panel for the model.

The instrument used for this study was a set of evaluation survey questionnaire. The questionnaire consisted of 25 questions divided into two parts: 1) experts' personal details, and 2) experts' view of the model. The first part consisted of two sections: Section A and Section B. Section A was used to elicit participants' background information and Section B was used to gather information on participants' use of mobile technologies. The second part served to elicit experts' view of the model. In detail, this part aimed to gather the participants' collective opinions on the evaluation of the model (Figure 1) on the following aspects and their respective quantitative items as listed in Table 1.

Table 1
Aspects and quantitative items to evaluate the model

	Aspects		Quantitative Items
1	Suitability of elements (learning activities)	1.1	Experts' view on mLearning activities proposed in the model
2	Domain classification of the learning activities	2.1.	Grouping of mLearning activities into three domains as shown in the model: knowledge input activities, enabling skills activities, and evaluation and reflection activities
		2.2.	List of activities grouped under knowledge input activities as shown in the model
		2.3.	List of activities grouped under enabling skills activities as shown in the model
		2.4.	List of activities grouped under evaluation and reflection activities as shown in the model

Table 1 *(continue)*

Aspects		Quantitative Items	
3.	Relationships among the learning activities	3.1.	Relationships among the mobile learning activities in the knowledge input activity domain as shown in the model in aiding the students to achieve their learning needs and course outcomes
		3.2.	Relationships among the mobile learning activities in the enabling skills activity domain as shown in the model in aiding the students to achieve their learning needs and course outcomes
		3.3.	Relationships among the mobile learning activities in the evaluation and reflection activity domain as shown in the model in aiding the students to achieve their learning needs and course outcomes
		3.4.	Overall relationships among the mobile learning activities as shown in the model in aiding the students to achieve their learning needs and course outcomes
4	Suitability of the model in teaching and learning activities in aiding the students to fulfill their language learning needs and course outcomes	4.1.	The model shows a clear guide on how a language communication skills course can be conducted using mLearning in complementing the conventional classroom learning.
		4.2.	It is practical to use a network of interrelationship of learning activities in developing a model of mLearning implementation in guiding the curriculum implementers to conduct mLearning language lessons.
		4.3.	The model shows clearly how formal classroom learning activities could merge with informal mLearning activities to form a holistic learning experience for the students.
		4.4.	The model shows clearly how mLearning could promote and capitalise collaborative learning through formation of large and small 'learning society' among students through choice of collaborative online learning activities and the interrelationships among these activities.
		4.5.	The model shows clearly how one activity connects to other activities in assisting students through mLearning in achieving their learning outcomes.
		4.6.	The model could be used to guide the planning of course unit lessons in facilitating students' learning.
		4.7.	The model could be used as an example to develop other implementation models for other course subjects.

A pilot study was conducted on 12 lecturers from a tertiary institution using the instrument to improve the questionnaire items. However, the 12 lecturers were not included in the actual needs analysis study. The instrument was further validated by six curriculum and instructional technology experts. Reliability test was conducted on the survey questionnaire for all items that registered Cronbach alpha coefficient of .874, indicating high reliability for all items as shown in Table 2.

Table 2
*Reliability testing of evaluation questionnaire*

Cronbach's alpha	Cronbach's alpha based on standardised items	N of items
.874	.818	33

The main aim of this phase was to evaluate the model developed prior to this study (refer to Figure 1). As the study employed Fuzzy Delphi method to evaluate it, the procedure for this phase is elaborated in the following section.

Selection of Experts

The process of selection of respondents for this study was elaborated in the preceding section. In order to address the issue of fuzziness among the experts' opinion, a linguistic scale was determined to frame the respondents' feedback. The linguistic scale is similar to a Likert scale with an additional of fuzzy numbers given to the scale of responses based on triangular fuzzy number. For every response, three fuzzy values were given to consider the fuzziness of the experts' opinions: minimum value (m1), most plausible value (m2), and maximum value (m3) as shown in Figure 2.
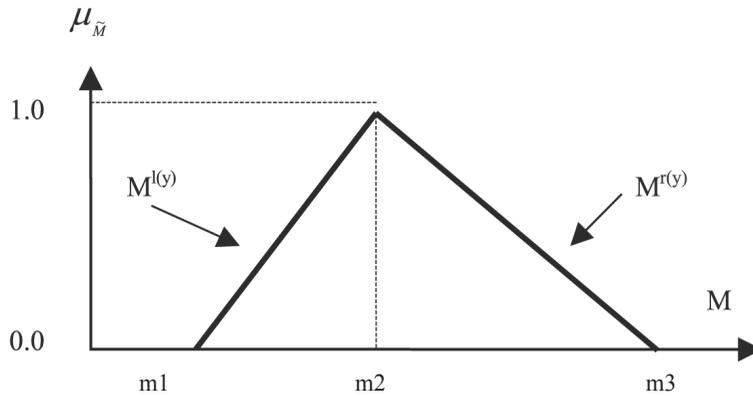
m1 = Minimum value; m2 = most plausible value; m3 = maximum value

Figure 2. Triangular Fuzzy Number

In other words, the linguistic scale is used to convert the linguistic variable into fuzzy numbers. The level of agreement scale should be in odd numbers (3, 5, or 7-point linguistic scale). The higher the scale, the more accurate the response analysis may be. In this study, a 7-point linguistic scale was used as shown in Table 3.

Table 3
Seven point linguistic scale

7-point linguistic scale			
Strongly agree	0.90	1.00	1.00
Agree	0.70	0.90	1.00
Moderately agree	0.50	0.70	0.90
Slightly agree	0.30	0.50	0.70
Slightly disagree	0.10	0.30	0.50
Disagree	0.00	0.10	0.30
Strongly disagree	0.00	0.00	0.10

The experts' responses with the correspondent fuzzy number scales for each quantitative items on their view of the model were inserted in an excel spreadsheet. This is to obtain the average for m_1, m_2, and m_3. The next step was to calculate the difference between the experts' evaluation data and the average value for each item to identify the threshold value d, using the formula below:

$$d\left(\tilde{m},\tilde{n}\right) = \sqrt{\frac{1}{3}\left[(m_1-n_1)^2+(m_2-n_2)^2+(m_3-n_3)^2\right]}.$$

Based on the formula, m_1, m_2, and m_3 are average values for all the experts' evaluation; n_1, n_2, and n_3 are fuzzy values for all three values for every expert.

The threshold value is important to determine the consensus level among experts. According to Cheng and Lin (2002), if the threshold value is less than or equal with 0.2, then all the experts are considered to have achieved a consensus. The overall group consensus should be more than 75%, otherwise a second round of Fuzzy Delphi needs to be conducted. Once the group consensus is achieved, the aggregate fuzzy evaluation is determined by adding all the fuzzy numbers for each quantitative item. The final step of the procedure of the evaluation phase is called the defuzzification process. The defuzzification value for each quantitative item was calculated using the following formula:

$$A_{max} = 1/4 * (a_1 + 2a_m + a_2)$$

Where, A_{max} is Defuzzification value for each item (performance initiatives); a_1 is the fuzzy evaluation for the minimum value, a_m is the fuzzy evaluation for plausible value, and a_2 is the fuzzy evaluation for the maximum value for the particular item.

In the general application of Fuzzy Delphi, defuzzification is essential to classify the variables agreed by consensus of the experts through ranking of the variables (quantitative items). In this study, the calculation of defuzzification value and the rankings were used to identify which quantitative items were agreed upon in evaluating the mLearning implementation model. The range of defuzzification value that was accepted as consensus among the experts was within the range of 33.6 to 46.8. Defuzzification value of 24 was the minimum value for experts' consensus under a hypothetical agreement of 'moderately agree' for all quantitative items. Defuzzification value of 46.8 was the maximum value for indication of consensus experts' opinion under hypothetical agreement of 'strongly agree' for all quantitative items. Hence, defuzzification value of less than 24 indicated experts' consensus disagreement with the quantitative item while a value ranging from 33.6 to 46.8 indicated consensus agreement to strong agreement among the experts. The following Figure 3 elaborates the range of agreement among the experts. Thus, the method used to validate the model was a modified Fuzzy Delphi method (with a different view of the use of defuzzification value and rankings for evaluation purposes as explained).

DV 46.8	• Experts consensually Strongly Agree
DV 42.0	• Experts consensually Agree
DV 33.6	• Experts consensually Moderately Agree
DV 24	• Experts consensually Slightly Agree
DV 14.4	• Experts consensually Slightly Disagree
DV 6	• Experts consensually Disagree
DV 1.2	• Experts consensually Strongly Disagree
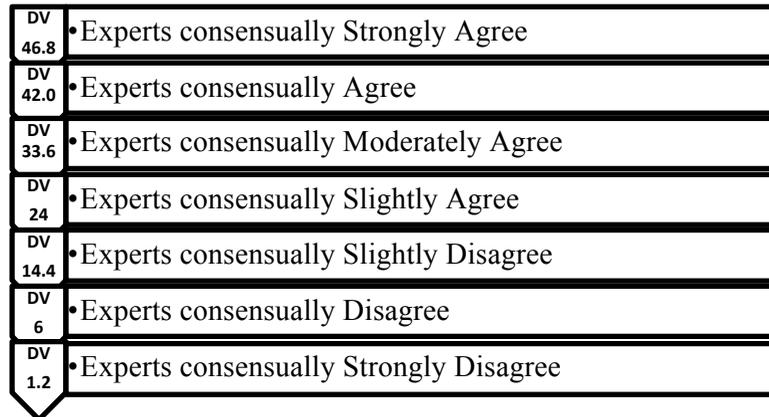
Note: DV- Defuzzification Value

Figure 2. Elaboration of experts' agreement based on defuzzification value

FINDINGS

Based on a seven-point linguistic scale, the responses of the participants (experts) to the evaluation survey questionnaires were obtained. The overall threshold value *d* for this study was 89.9% which exceeded the minimum of 75%. This indicates that the participants have reached the required consensus in their views for all questionnaire items of the evaluation questionnaire in evaluating the mLearning implementation model for the undergraduate English language learning course of this study. Since consensus among the participants had been achieved, the next step was to seek the findings for the participants' collective opinions on the evaluation of the model in terms of their agreement on the aspects and their respective quantitative items as listed in Table 1.

Aspects (1) to (3) were evaluated as these aspects represent the elements (learning activities) and the relationships among the elements, which constitute the main parts of the structure of the model. The suitability and clarity of the model in giving a clear and valid guide to mLearning implementation depend on the structure of the model. Aspect (4) was included to evaluate the purpose of the model. The overall mapping results for all four aspects in evaluating the model is concluded in Table 4. The table does not only show defuzzification values for all quantitative items but also includes the ranking of the items. The ranking of the items indicates how an item compares with other items in the degree of agreement among participants. Ranking number one (1) is taken as the highest rank consistent with the highest defuzzification value registered to the particular item.

Table 4
Defuzzification value and ranking of quantitative items

Item response	Average	Fuzzy evaluation	Defuzzy	Ranking
1.1	(0.75, 0.90, 0.96)	(36, 43.1, 45.9)	42.03	10
2.1	(0.74, 0.90, 0.97)	(35.6, 43, 46.6)	42.05	9
2.2	(0.65, 0.82, 0.94)	(31, 39.5, 45.2)	38.8	16
2.3	(0.80, 0.93, 0.98)	(38.4, 44.7, 46.8)	43.65	1
2.4	(0.75, 0.90, 0.96)	(36, 43.2, 46.2)	42.15	7
3.1	(0.75, 0.90, 0.96)	(36, 43, 46.3)	42.08	8
3.2	(0.73, 0.88, 0.95)	(35, 42.2, 45.6)	41.25	12
3.3	(0.68, 0.85, 0.95)	(32.8, 40.7, 45.6)	39.95	14
3.4	(0.78, 0.92, 0.98)	(37.4, 44, 46.8)	43.05	2
4.1	(0.68, 0.84, 0.94)	(32.6, 40.3, 45.1)	39.58	15
4.2	(0.75, 0.90, 0.97)	(36.2, 43.2, 46.4)	42.25	5
4.3	(0.76, 0.90, 0.97)	(36.4, 43.3, 46.4)	42.35	4
4.4	(0.75, 0.88, 0.94)	(35.6, 42.3, 45.5)	41.43	11
4.5	(0.75, 0.89, 0.96)	(36.6, 43.1, 46.1)	42.23	6
4.6	(0.77, 0.93, 0.99)	(33.8, 41.7, 46.2)	40.85	13
4.7	(0.71, 0.87, 0.95)	(36.2, 43.5, 46.7)	42.48	3

DISCUSSION

As described in the methodology section, in a conventional Fuzzy Delphi, the ranking of the items is to determine the variables for the scope of a case being studied. Quantitative items that received higher ranks could be considered as a variable or an element chosen as the result of the study. However, in this study, the ranking is used to compare the level of agreement of items among the participants. From Table 4, item 2.3 (List of activities grouped under enabling skills activities as shown in the model) is ranked first in participants' preferences while item 2.2 (List of activities grouped under knowledge input activities as shown in the model) received the lowest rank in the level of participants' agreement.

However, the most important findings of the study are the defuzzification values of the items in participants' evaluation of the interpretive mLearning implementation structural model for undergraduate English language learning course. Overall, from the findings presented in this study, as the defuzzification values for all quantitative items exceed the minimum value of 33.6 (refer to Figure 3), the findings conclusively suggest that the participants have consensually agreed to all four aspects of the evaluation of the model. Thus, according to the participants or experts for the study, the model is suitable to serve as a guide in the implementation of mLearning as learning support for undergraduate formal English language learning for *Professional and Communication Skills* course at the tertiary

institution. The model exemplifies how students can gain assistance in overcoming their lack of language competence to cope with their professional communication skills course and to achieve their course outcomes. In terms of implications to instructional practices, the model is also able to guide education stakeholders in designing meaningful and sustainable learning experiences mediated through mobile technology to cater to the new mobile generation of learners without forsaking the long institutionalised traditional formal classroom learning.

The model may be adopted or adapted to implement mLearning in a formal classroom at tertiary level. Based on the learning activities and their interrelationships, course instructors can plan appropriate mLearning lesson plans and select suitable mobile devices to facilitate learners' language learning needs and fulfill their course objectives. For example, based on the model (Figure 1), the lecturer may begin the language course by establishing learning contract (activity 9) with the students and encourage them to form social blog groups (activity 10) before proceeding to giving lectures on communication (activity 1) or encouraging the students to get and share information about the course content (activity 5). Activities 9 and 10 that had been conducted earlier can facilitate activities 1 and 5, for example to allow students to share and understand the principles of communication through interaction in classroom and via mobile devices. As the course progresses in the lecturer's lesson plan, the low achieving students can be assisted through mentorship (activity 12) and subsequently through mobile video conferencing (activity 7), mLearning forums (activity 13) and small group discussion through social blogs (activity 11). At the same time, referring to the model, students who may want to present a mock-trial presentation can do so through activity 18 (search for presentation materials) and then record their oral presentations to be uploaded on social blogs to be commented by others (activity 6). Further discussion on the students' improvement can be conducted through the same activities 7, 11, 12, and 13 as mentioned here. Since the activities involve synchronous and asynchronous interaction and collaboration, students are required to be equipped with smartphones with audio-video streaming capabilities.

Another pertinent point is that activities 1 to 5 and 9 to 10 support the notion of mLearning where formal learning and informal learning are integrated seamlessly (So, Kim, & Looi, 2008). Based on the model (Figure 1), the formal classroom learning though lecture (activity 1) is further complemented by activity 5, where students elaborate upon what they learned in class by sharing content through mobile tags using mobile devices. However, as discussed earlier, beyond the notion of content sharing, the integration of formal and informal learning allows students to take charge of their own learning together (student-centred learning) through both face-to-face and wireless online interaction which further enrich their learning experiences. Activities

9 and 10 further support student-centred learning concept where activity 9 promotes learners' autonomy by managing own learning via learning contracts facilitated by the establishment of online communication through activity 10. For example, through social blogs, the in-class discussion can be continued on the online platform which can subsequently result in knowledge negotiation among learners. Certainly, the limited time and space of classroom learning alone cannot accommodate these learners' needs as language learning requires more time for learners' practice and exposure for skill development. Moreover, collaborative learning strives on continuous interaction and communication among learners and this is where mLearning serves as ideal medium for these learning contexts and students' learning needs (Gong & Wallace, 2012).

Based on the model in Figure 1, it is important to reiterate that considering the relationships among the language activities, activities 9 and 10 qualify as important precedent activities to be conducted before subsequent activities for effective mLearning implementation. For example, forming social blogs among students in activity 10 serves as important grounding for language activities 8 (online discussions on task given), 16 (collaborative online language games), 12 (mentorship), 7 (video conferencing among learners), 6 (record and upload presentations to elicit comments), and evaluation activities (activities 19 to 24). The relationships among these language activities (activities 6, 7, 8, 10, 12, 16, and 19 to 24) supports Baggio's

(2008) findings from his study on the use of IPod among undergraduate language learners. He reported that his students were able to use their mobile devices in establishing communication networks among themselves and their tutors to aid in their language learning collaboration. Through the networks, the students recorded their oral assessments and uploaded them to a virtual learning environment (VLE) to allow tutors' feedback. These activities are categorised either as knowledge input activities or as enabling skills activities. The relationship among the activities as described above conforms to the social constructivist learning theory, which capitalises on supporting learners' language learning through interaction and collaboration. According to the theory, knowledge is best negotiated and acquired through interaction and collaboration with each other, aligned with beliefs of social constructionists (Kurt & Atay, 2007).

The mLearning implementation model (Figure 1) also suggests that collaborative redesign of language activities (activity 14) and collaborative redesign on method (activity 15) contribute to the development of students' communication skills and language competence to engage effectively in online groups. Both the activities promote students' ownership of their learning process where they can choose what and how to learn to achieve their language learning goals. These activities are further supported by activities 7, 8 and 12 in helping students improve their language competence and communicative skills through video

conferencing, online discussion, and peer mentorship where students are engaged in collaborative task solving and content sharing (activity 18). Students, especially the low to moderately competent students will benefit more through these online activities and for those who need further assistance can share their learning problems too (activity 11). In short, referring to the role of the activities in the respective clusters, the course instructors need to pay attention to all the 24 activities as the activities individually and connectedly have influence on the implementation of mLearning for the English Language learning course.

CONCLUSION

This study serves as an example on how Fuzzy Delphi as a decision making method can be used to evaluate a technology-mediated education model. Other existing methodologies such as focal group interviews, simple survey questionnaires conducted on implementers (teachers or instructors), or a more sophisticated technique such as Stake Countenance model (Stake, 1967; Wood, 2001) have also been used in evaluation of education products (for example, model, module, courses, or education implementation framework). The introduction of the Fuzzy Delphi method in this study is not intended to replace these previous methods, but rather, to compare, focal group interviews or a simple survey questionnaire would be useful in eliciting the end users' views (such as from teachers, lecturers, or instructors) on the model, for

instance, how the model may guide them in using mLearning in language learning. Stake countenance model on the other hand is useful in analysing the effectiveness of an education course or programme through students' assessments on three stages: pre-implementation of the course, during the implementation of the course, and post-implementation of the course. Fuzzy Delphi method as illustrated in this study capitalises on selected experts' collective views in making decision on a complex problem as outcome of the evaluation.

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