MODELLING THE SUCCESSFUL INTEGRATION OF MOBILE AUGMENTED REALITY TECHNOLOGY (MART) AMONG MALAYSIAN PRE-SERVICE TEACHERS

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Abstract:

The integration of mobile augmented reality technology (MART) into the education system since the last two decades have brought to the topic of discussion among many scholars. Although numerous studies have highlighted its huge potentials and benefits toward both teacher's and students' teaching and learning process, several researchers reported that teachers' readiness to integrate mobile augmented reality technology is still uncertain. Given the importance and consideration of research that has been undertaken, the present study was set to examine the Malaysian pre-service teachers' readiness toward integrating MART into their learning and future teaching process. The Technology Acceptance Model (TAM) was adapted as the theoretical grounding of the study in explaining and predicting pre-service teachers' decision to integrate mobile augmented reality technology. Data of the study was gathered from 303 Malaysian pre-service teachers and were analysed using the descriptive analysis of SPSS and Partial Least Square (PLS) of Structural Equation Modelling (SEM). Findings from the study demonstrate that pre-service teachers' readiness to integrate MART is at a moderate level. The study also suggested that pre-service teachers' perceived usefulness has the most significant direct effect on their decision to integrate MART. On the basis of these findings a purpose model is developed, and implications of theory development, practices, and policymaking are discussed in this paper.

Keywords:

Mobile Augmented Reality Technology (MART), Augmented Reality (AR), Technology Acceptance Model (TAM), Pre-service Teachers

Introduction

The emergence of evolving mobile augmented reality technology (MART) has leaved a significant impact on every aspect of educational development. This scenario has become more demanding where mobile devices, such as hand phones, tablets and its applications have become more commonplace and compelling among students. This situation has required for its effective adoption into existing educational environment in order to provide a new way for student to learn and think as well as to promote meaningful learning. Current learning situations reassure students to shift towards self-access, self-paced education and self-learning. It is aligned with the initiative in the Malaysia Education Blueprint 2015-2015, to encourage technological innovation to be utilized for education and offer more personalised learning experiences to all student (Ministry of Education Malaysia, 2015). Students are expected to emerge in scaffolding learning through technology-enhanced environment where they can explore and grab as many information at their fingertips.

Motivation and involvement of students in learning are often correlated with the complexity of the learning content. Most of students are struggle in comprehending complex learning content and require strong visualisation (Omar, et al., 2019). This situation urged the integration of MART as it is able to demonstrate phenomena visually in three dimensions (3D). This directly able to reduce students' cognitive load in comprehending complex learning content and increase their motivation in learning through MART. Providing motivation and fun are expected to produce good learning and achieve learning's objectives (Wardani et al., 2020). In similar vein, the potentials and advantages of integrating MART in classrooms have been proven to improves student's knowledge (Adnan et al., 2019), provide active learning environment (Mat-jizat et al., 2016), offer a flexible learning experience (Ismayatim, et al., 2019), and preparing students for demanding workplace.

Nevertheless, despite those benefits and potential of MART in learning, there is little evidence of teachers fully embracing it into their pedagogical practice. Even though pre-service teachers were aware of the existent and potentials of MART, its integration in education setting is remain unexplored and limited (Shang et al., 2017). Few researchers have informed that MART potential in education is considerably low (Issham et al., 2016) and still at the initial stage (Nizar et al., 2019). In light of this unpleasant situation, it was decided to undertake the present study which investigated pre-service teachers' readiness toward integrating MART into their classroom instruction. Noted as key players and change agents of education, determination of pre-service teachers' readiness and acceptance toward MART will ensure its successful integration in the next coming future.

Conversely, there are many factors contributing to this unpleasant situation. Few studies have reported that unsupportive system (Ismayatim, et al., 2019), insufficient resources (Ibanez et al., 2016), unstable Internet connectivity (Shang & Wu, 2017), and lack of appropriate devices (Hanafi et al., 2016) as barriers that hinder teachers' decision to integrate MART into their classroom instruction. Other studies have also found that teachers' misconception, negative attitude (Yilmaz, 2016), and lack of knowledge and skill (Nizar et al., 2019) as causes of this situation. Given these arguments and findings, this study is set out to determine factors affecting MART integration by Malaysian pre-service teachers. Identifying pre-service teacher' readiness to integrate MART and the stumbling blocks that impinge its effective integration together with the conditions that would assists them to overcome this situation was seen to be a critical and important outcome of the study. The proposed model of MART

integration will allow this study to serve as a guide and reference for teachers, school organizations, teachers training institutions and the government in the establishment of a standard of successful MART integration.

Research Model and Hypotheses
The Technology Acceptance Model (TAM) was chosen as the grounded theory of the study. Acknowledged as the most widely used and influential model (Sagnier et al., 2020), individual's intention to use a technology is determine by two specific beliefs of TAM namely perceived usefulness (PU) and perceived ease of use (PEoU). PU is defined as an individual's degree of beliefs that using particular technology will enhance job performance; while PEoU is defined as an individual's degree of beliefs that using a particular technology will be free from effort (Davis, 1989).
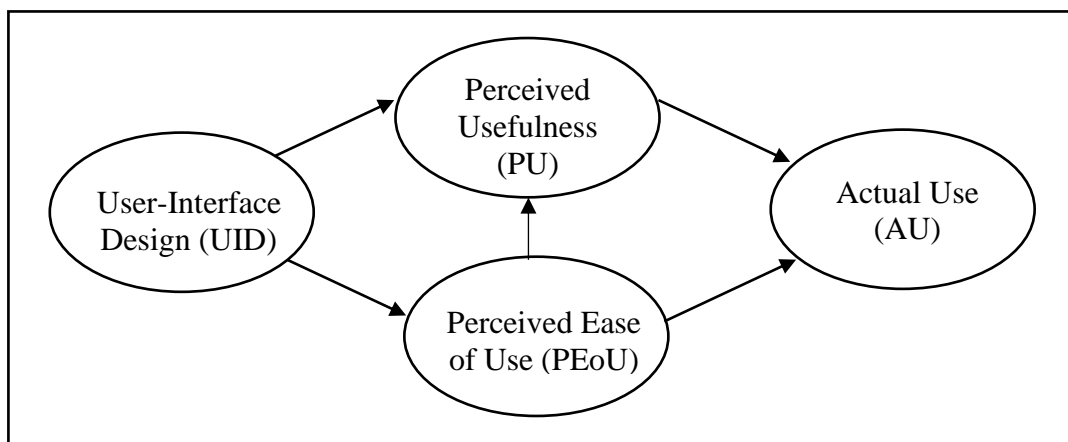
Figure 1: The Research Model

As shown in Figure 1, the relationship of designated path of the research model proposed that both individuals' perceived usefulness (PU) and perceived ease of use (PEoU) will determine their decision to integrate MART. This statement indicates that individuals would enhance their use of proposed technology whenever it is useful for them in completing or increase their performance in daily task (Suleman et al., 2020; Marinkovic et al., 2019). In similar vein, the use of proposed technology would increase whenever individuals perceive it as an easy and useful for them (Suleman et al., 2020; Hafit et al., 2020). Conversely, the research model of the study also proposed that individual's actual use would bring more impactful whenever they perceived it as an easy and useful for them (Sagnier et al., 2020; Binaymin et al., 2019). Given these statements, the present study proposed the following hypothesis as:

H_1: The Malaysian pre-service teacher's PU positively related to their AU of Mobile Augmented Reality Technology (MART).
H_2: The Malaysian pre-service teacher's PEoU positively related to their AU of Mobile Augmented Reality Technology (MART).
H_3: The Malaysian pre-service teacher's PEoU positively related to their PU of Mobile Augmented Reality Technology (MART) AU.

In addition, the study also suggested that the relationship of designed path of the user-interface design (UID), which was added as an external variable of the study predict both individual's PU and PEoU. This assumption was made considering that the elements of UID is an essential

factor in developing information materials of MART. Further, a well-deigned UID able to assist individuals in comprehending learning content effectively and increase the functionality of the materials (Xin & Ye, 2018). Similarly, determination of good UID is important to ensure individuals would be free of effort and perceive a good experience with the materials usage (Yalcin & Kutlu, 2019). Thus, the following hypothesis was formulated as:

H_4: The mobile augmented reality technology (MART) user-interface design (UID) positively related to Malaysian pre-service teacher's PU.
H_5: The mobile augmented reality technology (MART) user-interface design (UID) positively related to Malaysian pre-service teacher's PEoU.

Research Methodology

A self-developed MART material was created as an experimental tool of the study. The material consists of two augmented reality (AR) objects, which are a booklet and its application. The booklet is a representative of physical AR object, while the application serves as virtual AR object. Both AR objects (booklet and its application) were used simultaneously to enhance the AR experiences. The respondents of the study are 303 pre-service teachers from three different public universities in Malaysia. They were given a week to explore the potentials and functionality of both AR objects, before addressing a survey questionnaire. A descriptive statistical analysis of SPSS was employed in assessing pre-service teachers' readiness toward integrating MART, while the Smart-PLS and AMOS software of the Structural Equation Modelling (SEM) were utilized to explore and evaluate the proposed research model.

Research Findings

This section is presented in three different sub-sections. The first sub-section tested the reliability of items for each construct as projected in the research model, while the second sub-section examined pre-service teachers' readiness toward integrating MART. The final sub-section will address the research hypotheses and the fit indexes of the research model.

Reliability Construct

The value of Cronbach alpha was determined in assessing the internal consistency reliability for survey constructed items of the study. As presented in Table 1, all the constructs have achieved acceptable reliability value (Kline, 2011). This result can be explained from constructed items that were adapted from established model of technology acceptance questionnaires.

Table 1: Cronbach's alpha value for five constructs

Construct	Number of Item	Cronbach Alpha
Readiness	9	.718
Perceive Usefulness (PU)	5	.861
Perceive Ease of Use (PEoU)	5	.832
Actual Use (AU)	5	.826
User-interface Design (UID)	5	.880

Pre-service Teachers' Readiness toward Integrating MART

Descriptive analysis was employed in determining pre-service teachers' readiness toward integrating MART. Findings from Table 2 informed that although pre-service teachers not sure how far MART can be interesting in their learning process (M=3.44); most of them eager to

know more about it (M=3.55). Nevertheless, although pre-service teachers are agreed that MART will ease learning and teaching process, and the potential of MART as new method of teaching, the low mean score of 2.76 and 3.01 respectively have indicate different findings. Further, with an overall mean score of 3.37, which is slightly above the center point (center point is 3.00), suggested that pre-service teachers were appeared as moderately ready to integrate MART into their teaching process.

Table 2: Descriptive Statistics of Pre-service Teacher' Readiness toward MART

Items	Mean (M)	Std.Dev (SD)
I prefer conventional learning than learning through MART	3.42	.979
MART will make my teaching and learning process difficult	2.76	.847
I am not ready for MART being implements the method now	3.01	.836
I would like my instructor to integrate with MART in my class	3.31	.856
I know what MART all is about	3.44	.913
I don't mind paying extra money for MART	3.61	.890
I would like my instructor to integrate MART in my learning process	3.68	.795
I want to know more about MART	3.55	.846
I am afraid I will spend more money on my mobile devices bill because of MART	3.56	.960

Note: Overall mean is 3.37

Research Hypotheses Testing
The relationship of designated path of the proposed model were tested through path coefficient analysis, thus used to verify research hypothesis of the study.

Table 3: Hypotheses Testing

H	Independent Variable		Dependent Variable	R^2	Path Coefficient	*P* value
H_1	Perceive Usefulness (PU)	>	Actual Use (AU)	0.808	0.681	0.000
H_2	Perceive Ease of Use (PEoU)				0.236	0.135
H_3	Perceive Ease of Use (PEoU)	>	Perceive Usefulness (PU)	0.847	0.620	0.000
H_4	User-Interface Design (UID)				0.343	0.000
H_5	User-Interface Design (UID)	>	Perceive Ease of Use (PEoU)	0.696	0.834	0.000

Findings in Table 3 indicates that all the research hypotheses were significant, except for H_2. The R^2 value of AU indicate that 80.8 percent of its variance was predicted from pre-service teachers' PU. Additionally, findings presented in Table 3 suggested that 84.7 percent of the variance in PU is contributed by pre-service teachers' PEoU and MART UID, where PEoU (path coefficient of 0.620) shows a greater influence toward PU, as compare than UID (path coefficient of 0.343). Finally, although MART UID was not found to be the greater contributor of PU, but it serves a major influence towards PEoU, where its contributed 69.9 percent toward

the variance from MART UID. Figure 2 provides the representation of the model with its R^2 coefficient.
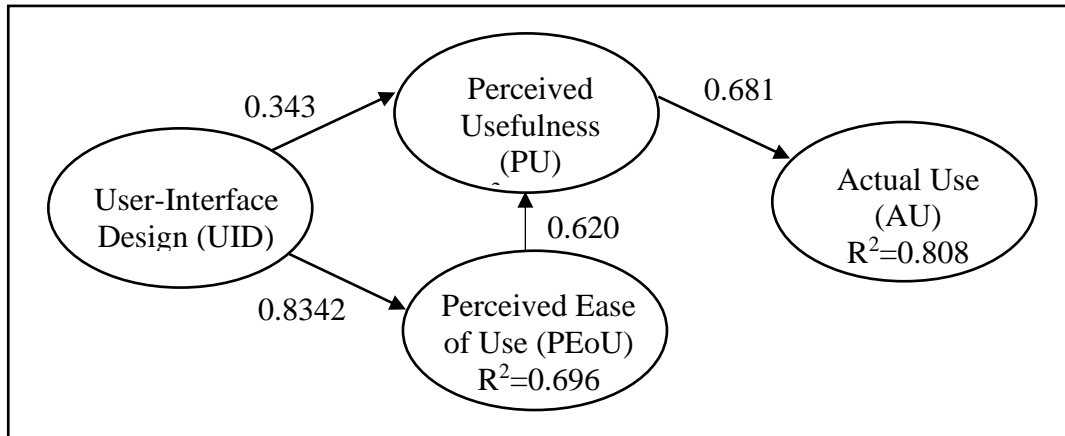
Figure 2: The Research Model Depicting Significant Paths

The Model Fit Index

Five model fit indicators, which are RMSEA, GFI, CFI, TLI, and Chi-Square (x^2/df) were determined in assessing fit of the research model (Hair et al., 2017). As shown in Table 4, all model fit indicators meet the recommended thresholds. This confirmatory evidence indicates that the proposed structural model is in a good fit.

Table 4: Model fit indexes for research model

Fit Indexes	Values	Thresholds	References
GFI	0.904	GFI > 0.90	Hu & Bentler (1998)
CFI	0.970	CFI > 0.90	
TLI	0.965	TLI > 0.90	
RMSEA	0.053	RMSEA 0.08	
Chi-Square (x^2/df)	0.105	X^2/df < 0.3	Marsh & Hocevar (1985)

Research Discussion

Generally, the present study concludes that the Malaysian pre-service teachers are moderately ready to integrate MART into their leaning and future teaching process. This finding is quite salutary when compared to other studies (i.e. Issham et al., 2018; Nizar et al., 2019). The study also found that although pre-service teachers are excited on the possibilities and potentials of MART, but they are still unsure about how MART should be integrated into their teaching and learning process. Moreover, pre-service teachers' agreement and readiness to integrate MART was also influenced by factor of cost and budget that might affected. Based on these findings, it is suggested that in order to build pre-service teachers' confidence and proficiency on how to integrate technology into classroom, their need to have access to high quality professional development courses and the technology itself. Similarly, a study by Sobodic and Balaban (2019) also reveal that users are more likely to posit a higher MART adoption when it is convenient to use and practical for them.

In explaining and predicting pre-service teachers' decision to integrate MART, the study has found that Malaysian pre-service teachers' perceived usefulness (PU) as the main predictor.

This finding correlates with statement suggested that a proposed technology is more likely to be accepted when it is seen to be useful by the user (Mutterlein et al., 2019). This finding can also be explained by pre-service teachers' familiarity and commonality with mobile technology and its applications. As suggested by Mou et al. (2016), the more user confidence and familiar with a proposed technology, the more likely it will be accepted. Based on this understanding, there is a need for teacher training programs to provide pre-service teachers with appropriate knowledge, ideas, skills and experience about the better use of MART in classrooms.

Conversely, the study has indicated that MART user-interface design (UID) has a significant relationship toward both pre-service teachers' PU and PEoU. This result can be explained by a statement that a well-designed user interface able to assist individuals in comprehending learning content effectively and increase the functionality of the materials (Xin & Ye, 2018). The application of the Multimedia Learning Theory, and the Gestalt Theory principles has served as guidelines in ensuring effective design and development process of MART. Based on the present study finding, it is suggested that a well systematic design and development procedures of MART material, will ensure the user would be free of effort and perceive a good experience with it, thus ensure MART integration.

Conclusion

The result of this study has provided some insights into how ready Malaysian pre-service teachers to integrate MART into their teaching process. Based on the results, this study informed that their readiness is at moderate level. The pre-service teachers were found familiar, confidence and eager to integrate MART, although they are still unsure about how it should be integrated. This statement is expected because as a technology savvy generation, pre-service teachers are more likely seeing technology as socializing and entertainment tools, rather than its other potentials. In addition, this situation might also due to limited available teaching and learning applications, that able to encourage the integration of MART in classrooms. This study therefore suggests that current efforts and initiatives by the Malaysian Ministry of Education initiatives to provide sufficient quality MART resources must be continued. In similar vein, the finding also suggests that the provision of sufficient support by the authorities is critical in ensuring that Malaysian pre-service teachers successfully integrate MART into their leaning and future teaching process. Specific policies and guidelines for school leaders and teacher therefore need to be provided by the authorities to ensure the success and effectiveness of MART integration.

Another important finding of the present study informed that Malaysian pre-service teachers' perceptions about the usefulness of MART was found to be an important predictor of its integration. The study suggests that the more the Malaysian pre-service teachers perceive MART as being useful, the more likely they will integrate it into their teaching process. It is therefore recommended that the curriculum for Malaysian teacher training programs should focus on the usefulness of MART into teaching and learning processes. Although all Malaysian training institutions does include common technology courses in their curriculum, findings derived from this study suggested that the Malaysian pre-service teachers need to be expose to continuous technological and pedagogical development courses. The conduct of professional development courses also is expected to be tailored in meeting teachers' specific needs and match pedagogical approaches.

The present study found that MART user-interface design (UID) as an essential factor toward Malaysian pre-service teachers' MART integration. This statement is in line with notation indicating that a well-designed user interface able to assist individuals in comprehending learning content effectively, which increase the functionality of the materials. Further, users would also perceive the technology as useful and free of effort whenever it able to address their needs and enable greater personalization of the learning experience with it. Hence, systematic consideration should be outlined in ensuring successful design and development process of MART happen. Lastly, the proposed model for Malaysian pre-service teachers' MART integration will allow this study to serve as a guide and reference for the teachers, school organizations, teachers training institutions and the government in establishing a standard of successful integration of mobile augmented reality technology (MART) into education system.

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