

Improving Learning Experience of Probability and Statistics Using Multimedia System

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Abstract—In this 21st century, the rapid development and growth of technology has enhanced teaching and learning experiences effectively in the delivery of learning contents. However, there are still lacking of integration of information technology (IT) in teaching although IT is pervasive. This study was conducted to determine the relationship between Information Technology (IT) capabilities, learning experiences and performance of teaching and learning Mathematics. Multimedia Probability and Statistics System (MMPASS) was developed and used as the IT capability framework to determine the effects on students' learning experiences towards performance of Mathematics. The sample size of this study were 66 students of foundation programme who are taking Probability and Statistics subject. The subject was delivered to two different groups of students; “with” and “without” the MMPASS. Findings showed that students' learning experiences and performances of their academic achievement have been improved by using MMPASS. Hence, MMPASS is one of the effective IT capability in improving performance of teaching and learning Mathematics.

Keywords—Teaching and Learning Experience, Multimedia Content Learning, Performance of Mathematics, Technology Integration in Teaching and Learning, Malaysia.

1 Introduction

In today's digital age, IT capabilities facilitate teaching and learning Mathematics. Students did not achieve a good result through traditional way of teaching and learning Mathematics because of uninteresting instructional contents and low confidence level. For instance, some concepts of Mathematics subject are too complex to teach in a traditional way. Multimedia content learning allows students to visualise the learning contents easily [1]. Multimedia Probability and Statistics System (MMPASS) is developed in this study as IT capability framework. The role of MMPASS is to teach Probability and Statistics subject in multimedia content learning. MMPASS can contribute a better learning experience, increase students' interest, increase students' confidence level and better performance in Mathematics. The changes in students' learning experiences can contribute to the improvement of academic performance

with the integration of IT are supported by previous studies [1, 2, 3, 4]. With this notation, the objective of this study is:

To develop an IT capability approach as an alternative approach to improve teaching and learning experiences and the performance of teaching and learning Mathematics.

2 Literature Review

The use of multimedia content based learning improves learning experience and contributes positive impacts to students [2, 3, 5, 6]. Multimedia content learning allows students to manipulate and visualise the learning contents in different ways [1]. MMPASS combined impactful multimedia elements in teaching and learning contents that enable students to visualise the learning contents. Multimedia elements consist of images, texts, audios, videos and animations [7, 8]. Xiaohui and Mark (2010) found different types of media elements can support multimedia learning and the purposes of the media elements are showed in Table1.

Table 1. Types of Media Elements in Multimedia Learning

Types of Media Elements	Purposes
Buttons, image, links, search, help	Navigation
Text	Explanation and narration
Diagram, process model (flowchart)	Examples, representations
Graph, chart, concept map	Demonstration, relationship
Animation, video, simulation	Virtually explain

All the above media elements play a significant role in forming and influencing learners' attitudes and behaviours towards multimedia learning. Hence, for the current study, the learning contents are presented through texts, images, audios and animations. For example, the steps of processes are explained by animation, using formulas and analogy examples. During the process of using MMPASS, students are able to see, hear and visualise the learning contents better.

Kelly, Daniel, Catherine and Fanny (2010) and Haaftamu (2016) pointed out the changes in students' learning experiences can contribute to the improvement of academic performance. Siti (2013) used e-audio and e-visual for teaching and learning and this study showed positive learning experience by using e-audio and e-visual. Users can learn through interaction. For instance, their interest or process of engaging can be measured by a test of retention such as learners can remember the presented learning materials and are able to apply the learning materials to solve new problems in their real life [9, 10, 11]. Besides, Ertmer and Ottenbreit (2010) and Dena (2014) stated that learning experience can be measured by academic achievement, user perceptions in terms of their interest, confidence and motivation level.

Based on proposed framework, relationships between IT Capabilities, learning experiences and performance of teaching and learning Mathematics were then operationalised as IT tools that enable IT Capabilities, IT Capabilities contribute better

learning experiences and better learning experiences that eventually improve the performance of Mathematics.

3 Methodology

3.1 Participants

The participants of this study were 66 students taking the subject of PSM0325 (Introduction to Probability) in their foundation study. They were divided into two groups based on their Cumulative Grade Points Average (CGPA) as the variable for proportional stratified sampling. On 20 December 2016, the two different groups of students were named as “with” and “without” system. The system is the MMPASS. The majority of the students were from 18 to 20 years old (64, 97%) and the remaining were from 21-23 years old (2, 3%).

3.2 Instrument

Survey and interview were conducted in this study. Questionnaire was used as instrument. The main objective of this questionnaire was to determine the perceptions of the students by using MMPASS. The questionnaire consists of four key constructs; “Learning Experience”, “System Quality”, “Information Content Quality” and “System Performance”. 5-point Likert Scale is used to allow the participants to express how much they agree or disagree on a statement. Some sample of statements in the questionnaire are as follows:

- The features of audio and animation in the MMPASS are helpful as I can easily get visualisation and explanation of the studying material
- The background music in the MMPASS was appropriately used
- The learning materials were clear and well structured
- MMPASS performance was smooth without any error

The instrument has been validated by three senior lecturers from Multimedia University Melaka (Malaysia). The questions were revised and amended based on their suggestions and comments. The Cronbach’s alpha coefficient for the instrument in this study is 0.846 for learning experience, 0.721 for system quality, 0.773 for information content quality and 0.708 for system performance. Thus, the instrument is reliable based on the accepted Cronbach’s alpha coefficient.

Interview was conducted directly to students to obtain further suggestions and comments on MMPASS. The students were asked in the questionnaire by asking a question for their willingness for the interview participation in the survey questionnaire. 5 students participated the interview after the actual survey.

3.3 Material

Multimedia Probability and Statistics System (MMPASS) was used as research material for this study. The system is incorporating impactful multimedia elements such as texts, images, audios and animations. The role of MMPASS is to teach Probability and Statistics subject in multimedia content learning.

Figure 1 shows an animated pedagogical agent (PA) that developed in MMPASS system. The role of PA in MMPASS system is either lecturer or tutor. High quality audio, simple language and slow speech rate are used by the animated PA. The animated PA delivers lecture materials in the form of texts, images, audios and animations to the students. The animated PA also guides the concepts and techniques to solve probability mathematical problems respectively.



Fig. 1. Animated Pedagogical Agent

Animations are used in MMPASS. Figure 2 is a sample of animation used to illustrate and visualise discrete random variable. The animation illustrates and visualises the concept of a car parked in a parking lot in a given time by using texts, car images, car action, time narration and audio. High quality audio, simple language and slow speech rate are used and the audio is paired with images to illustrate the car parking concept.

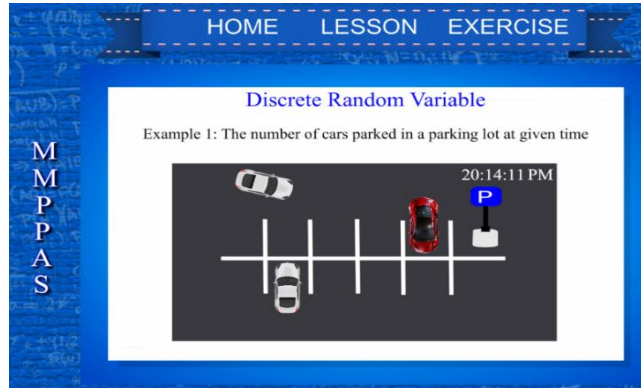


Fig. 2. Discrete Random Variable

Effective colours are used in MMPASS. Figure 3 shows a sample of three types of questions to test if a student can identify a probability distribution function. The solution of each question is linked by a blue solution button. For the text, a simple font type and colour coding are used such as blue, green, red, and yellow. Figure 4 shows a solution for example 3.4 that uses red colour to highlight the main formula and green tick to illustrate flow of explanation.

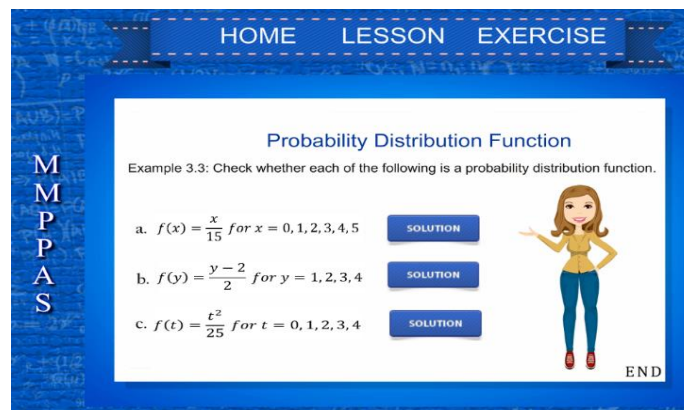


Fig. 3. Example of Probability Distribution Function

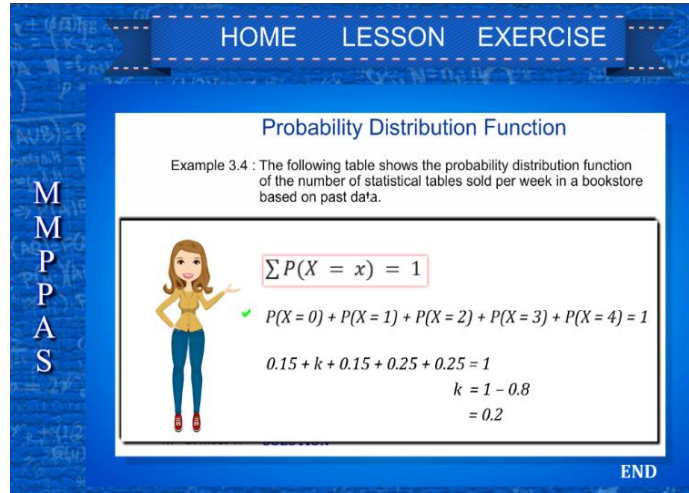


Fig. 4. Solution of Probability Distribution Function

Figure 4 shows a sample of the solution for each question and is linked in blue solution button. The green tick is used to indicate the audio explanation.

4 Research Procedures

The learning materials of MMPASS were designed based on “Discrete and Continuous Probability Distribution” subject for this study. There were two groups of students and the lessons were delivered for both group “with” and “without” MMPASS. The traditional class was conducted without MMPASS system and the learning materials were delivered through a lecturer. On the other hand, the system class was conducted with MMPASS and the learning materials were delivered using MMPASS. At the end of the lessons, students were given a quiz to answer based on their learning materials. Subsequently, a questionnaire was given to each student who used MMPASS to collect students’ perception towards MMPASS. The collected data was then analysed using Social Science Software Package (SPSS).

The method to determine students’ performance of quiz scores was compared by independent t-test. Besides, linear regression test was used to test the relationship between independent and dependent variable.

5 Results

5.1 Findings from questionnaire

Hypothesis 1 (H1): Student who uses the system performs better in answering quiz than student who does not use the system.

Table 2 shows that the mean scores are 9.65 for system and 8.03 for traditional. Descriptively, the system has higher mean score as compared to traditional group. The presented independent t-test result shows that there is a significant difference in scores between two groups as the p-value = .000 ($p < .05$). Therefore, it is proven that MMPASS is helpful in teaching and learning Probability and Statistics. Thus, H1 is accepted.

Table 2. Independent Sample *t*-Test

	Group	Mean	SD	t-Test for Equality of Means		
				t	df	Sig. (2. tailed)
Scores	Traditional	8.03	1.447	5.703	64	.000
	System	9.65	.566			

*Significant at .05

Hypothesis 2: Student who uses the system, the better the learning experience will be.

Table 3 shows a summary of variables tested in linear regression test with measures of standardized beta coefficient, p-value and significance level. The independent variables is statistically significant in the prediction of dependant variables. On other words, the observed relationship is statistically significant. Thus, H2a, H2b, H3, H4 and H5 are accepted.

Table 3. Linear Regression Test

Hypothesis	Independent Variable	Dependent Variable	B	P- value	Significance
H2a: The higher the interest of a student in learning, the better the learning experience of a student will be.	Interest	Learning Experience	0.839	.002	Yes
H2b: The higher the interest of a student in learning, the more confidence of a student will be.	Interest	Confidence	0.693	.000	Yes
H3: The better the system quality of a system is, the better the learning experience will be.	System Quality	Learning Experience	0.512	.000	Yes
H4: The better the information content quality of a system is, the better the learning experience will be.	Information Content Quality	Learning Experience	0.705	.000	Yes
H5: The better the system performance of a system is, the better the learning experience will be.	System Performance	Learning Experience	0.611	.000	Yes

5.2 Findings from interview

The findings of the interview on students’ perceptions towards the MMPASS and their current learning experience on Probability and Statistic are explained as follows:

Table 4. Findings from Interview

No	Description	Findings	Responses
1	The objectives were achieved as listed in each subsection of MMPASS.	In each subsection of MMPASS, the objectives were listed. Students were asked on how well they think these objectives were achieved. The majority of the students stated that the objectives were achieved as listed in each subsection of MMPASS.	<i>I think it is well achieved because students will know what they are going to learn and which part they need to focus 85% achieved because I take time to understand and adapt as this is a new technology in learning.</i>
2	Current learning system (Traditional Method) is inconsistent	The students state that the current learning system (Traditional Method) is less consistency even though they have direct interaction with teachers.	<i>We are able to interact with teachers but the examples given by the lecturer is inconsistency difference examples were given at random time difficult to catch up the lessons if skip class.</i>
3	The difficulties encountered by students while studying Probability and Statistics.	Most of the students stated that they face difficulties while studying Probability and Statistics.	<i>Yes, it takes time to understand concept sometimes it is confused to use the formula to solve the problem difficult to visualise the question you will stop to focus lecture lessons when it is difficult to understand.</i>
4	Multimedia content based teaching strategy useful for teaching and learning Probability and Statistics.	All the students stated that multimedia content based teaching strategy is useful for teaching and learning Probability and Statistics.	<i>It is more helpful in visual method of studies are interesting by using multimedia elements such as images and audio easy to visualise the content and concepts multimedia elements help to visualise the concepts better.</i>
5	Learning Probability and Statistics using the MMPASS particularly on discrete and continuous variable can facilitate students to engage them in the teaching and learning process.	Most of the students strongly stated that learning Probability and Statistics using the MMPASS particularly on discrete and continuous variable can facilitate students to engage them in the teaching and learning process.	<i>Yes, because this system is different experience for student and student get more excited the content with appropriate examples keep student engage in class and stay focus MMPASS teach student step by step what is discrete and continuous variable is about and show examples which enhance understanding.</i>
6	MMPASS make a difference to student's learning.	All the student stated that MMPASS able to make a difference to their learning experience.	<i>We can use this system as many times and helpful when we forget the concept multimedia elements make the learning experience more interesting this system able to show main point and concept probability and statistic MMPASS teach student what need to focus in topic.</i>
7	Suggestions and opinions for MMPASS for future enhancement.	Students were asked their suggestion and opinions for MMPASS for the future enhancement.	<i>MMPASS must include more examples in each topic and also give explanation in simple sentences so that it is easy for student to understand enhance graphics in MMPASS include more educational multimedia elements MMPASS able to communicate directly with student.</i>
8	Student confident to answer questions after integration of MMPASS into their learning.	Most of the student stated that they feel confident to answer questions from their Probability and Statistics topic after integration of MMPASS.	<i>Yes, very confident to answer the questions because the content of the system can help me in answering those questions.</i>

Overall, integration of MMPASS is well suited as an additional and a helpful tool for student in learning Probability and Statistic. Most of the students provide positive feedback on integration of MMPASS into learning Probability and Statistic.

6 Discussion

The findings of the result found that MMPASS has improved performance of teaching and learning Mathematics, especially in Probability & Statistics subject. Similar to the previous research studies including, [2, 3, 12, 13, 14].conclude that the changes in students learning experiences can contribute to the improvement of academic performance. Specifically, learning experience of students is improved with the integration of ITC. MMPASS system guides and does tutoring to students for the concepts and techniques to solve mathematical problems respectively. The t-test result of quiz scores proved that students from system group achieved the highest score than students from traditional group (Table 2).

Besides that, MMPASS delivers lecture materials in the form of animations, audio, text and images to the students. Students tend to be more excited and engaged in class because the new learning experience as compared to the traditional class. The better visualisation of contents leads students to have better learning experience. With MMPASS, student can easily understand the visualisation of those abstract concepts with the help of animation as well. The standardized beta coefficient for interest and learning experience scored 0.839 (Table 3).

According to Paturusi, Yoshifumi and Usagawa (2012), system quality is concerned with systems' errors, consistency of user interface, systems' response rate, user-friendliness and quality documentation. Students stated that interactive features and user-friendliness in MMPASS attracted their interest towards the lessons. The standardized beta coefficient for system quality and learning experience scored 0.512 (Table 3).

Besides, information content quality is concerned with accuracy, relevancy of data and timeliness created by an information system. According to Paturusi, Yoshifumi and Usagawa (2012) the delivery of information content should consider the type of information presented, better graphics, colour codes, not distracting or annoying, and the way of information delivery. Students agreed that the provided learning materials, visual examples, objectives of lessons, contents of learning materials, colour codes and design of text used in MMPASS are well structured and appropriate. The standardized beta coefficient for information content quality and learning experience scored 0.705 (Table 3).

Apart from system quality and information content quality, system performance of MMPASS also is an important aspect of students' learning experience [12]. Feedback from students shows that MMPASS performance was smooth without any error and they stated that they satisfied with the system. From the findings of this study, we can say that system performance has significant influence towards learning experience by using MMPASS. The standardized beta coefficient for system performance and learning experience scored 0.611 (Table 3).

7 Conclusion and Recommendation

As a conclusion, this study provides practical implications for three different group of people, namely lecturers, students and developers of IT tools. For lecturers, MMPASS has improvised performance of teaching and learning Probability and Statistics. In addition, performance of students in quiz has significantly improved in system class. Other than that, the findings of the study show positive perceptions towards Probability and Statistics by adoption of MMPASS as learning tool. This study also will be a bridge for developer to develop multimedia integrated IT tools by following proper guidelines and protocol as defined in this study. Furthermore, this study opens a pathway for developer to develop IT tools in different platforms such as mobile applications, web applications and standalone applications.

The proposed framework, relationships between ITCs, learning experiences and performance of teaching and learning Mathematics were then determined as IT tools enable ITCs, ITCs contribute better learning experiences and better learning experiences eventually improve performance of Mathematics. Hence, the findings of this study show that the MMPASS is one of the effective educational approaches in improving performance of students in the Probability and Statistics learning [13, 14]. Thus, in future research, it is recommended to be conducted in large scale with a longer time frame. More topics or subjects need to be involved in order to have more conclusive results. As students were satisfied with MMPASS, they suggested that MMPASS should be developed as two-way communication system. Student felt that this implication will be advantageous to them as they will be able to communicate directly with the system. Besides that, online quizzes and past year questions inclusion in MMPASS will be beneficial for students as they will be able to do self-assessment on their understanding level. All the implications from the students will be useful and considerable for the future research on multimedia system such as MMPASS.

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