JURNAL PENDIDIKAN SAINS DAN MATEMATIK MALAYSIA
VOL 11 NO 2 2021 / ISSN 2232-0393 / eISSN 2600-9307

Need Analysis for Development of Pedagogical Model Integration of Visualization Technology to Enhance Performance in Geometry

Analisis Keperluan Membangunkan Model Pedagogi Pengintegrasian Teknologi Visualisasi Meningkatkan Pencapaian Geometri

Thahirah Abd Fattah[1], Faridah Hanim Yahya[2], Saedah Siraj[3]
Henry Kurniawan[4], [4]Rosita Mat Zain [5]

[1]Maahad Muhammadi Pasir Mas, 17000 Pasir Mas, Kelantan
[1,2,3]Faculty of Human Development, Universiti Pendidikan Sultan Idris,
35900 Tanjong Malim, Perak, Malaysia
[4] Politeknik Negeri Lampung, Jl. Soekarno Hatta No. 10 Rajabasa, Bandar Lampung, Indonesia.
[5] Curriculum Development Division, Ministry of Education, 62604 Putrajaya, Malaysia
**Corresponding author:*

Published: 14 October 2021

To cite this article (APA): Abd Fattah, T., Yahya, F. H., Siraj, S., Kurniawan, H., & Mat Zain, R. (2021). Need Analysis for Development of Pedagogical Model Integration of Visualization Technology to Enhance Performance in Geometry. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *11*(2), 110-121. https://doi.org/10.37134/jpsmm.vol11.2.9.2021

To link to this article: https://doi.org/10.37134/jpsmm.vol11.2.9.2021

ABSTRACT

Students' low performance in Geometry is due to their problem in visualization. Studies showed that teaching methods using technology can improve students' achievement in Mathematics. Thus, teachers need a proper guideline on selecting proper technology that will support their teaching. The purpose of this study is to identify the need to develop a **pedagogical model** of the integration of visualization technology in Mathematics for the topic on Geometry, from the perspective of teachers. This study used a survey method. A total of 60 respondents who teach Mathematics in secondary schools from one of the state in Malaysia were involved in the study. The questionnaire was adapted from the Theory of Acceptance and Use of Technology (UTAUT) which consists of performance expectations, effort expectations, attitudes towards the use technology, social influence, self-efficacy, facilitating conditions, and behavioral intentions to use visualization technology in teaching. The data was analysed using SPSS version 25. The findings revealed that the majority of teachers (90.0%) agreed to have a **pedagogical model** that integrates visualization technology for Geometry topic in Mathematics. The findings also showed that gender is a factor that should be considered in designing the model. Hence, the findings suggest that the curriculum of mathematics for secondary school should be reformed to include **visualization technology** for **Geometry**.

Keywords: need analysis, pedagogical model, visualization technology, mathematics, Geometry

ABSTRAK

Pencapaian pelajar dalam Geometri adalah lemah, disebabkan oleh masalah visualisasi. Kajian-kajian lepas menunjukkan kaedah pengajaran menggunakan teknologi boleh meningkatkan percapaian pelajar dalam Matematik. Oleh itu, guru perlu garis panduan yang lengkap untuk memilih teknologi yang menyokong pengajaran mereka. Tujuan kajian ini ialah untuk mengenal pasti keperluan untuk membangunkan model pedagogi pengintegrasian teknologi visualisasi dalam Matematik bagi tajuk Geometri, dari perspektif guru. Kajian ini menggunakan kaedah tinjauan. Soal selidik telah didapatasi dari Teori Penerimaan dan Penggunaan

Teknologi (*Theory of Acceptance and Use of Technology or UTAUT*) yang mengandungi penerimaan dan kebolehgunaan teknologi visualisasi iaitu jangkaan prestasi, jangkaan usaha, sikap terhadap penggunaan teknologi dalam pembelajaran, pengaruh sosial, keadaan kemudahan, efikasi kendiri dan niat tingkah laku. Data dianalisis menggunakan SPSS versi 25. Dapatan kajian menunjukkan, kebanyakan guru (90%) bersetuju untuk membangunkan model pedagogi pengintegrasian teknologi visualisasi dalam Matematik bagi tajuk Geometri. Dapatan juga menunjukkan gender merupakan satu faktor yang perlu diambil kira dalam mereka bentuk model. Maka, kurikulum untuk Matematik Sekolah Menengah perlu diperbaharui untuk menerapkan teknologi visualisasi untuk Geometri.

Kata kunci: analisis keperluan, model pedagogi, teknologi visualisasi, matematik, geometri

INTRODUCTION

The best teaching practice is a pertinent factor that is required in order to increase students' achievements. Students' performances in mathematics at secondary school in Malaysia are always benchmarked against the scores from an international assessment for mathematics which is known as Trends in International Mathematics and Science Study (TIMSS). TIMSS is an international assessment formed by the International Association for the Evaluation of Educational Achievement (IAE), United States of America for mathematics, science and reading, conducted on 14-year-old students every four years. The Ministry of Education (MOE) of Malaysia has been participating in this study since 1999, with the aim of comparing Malaysian students' knowledge and skills with that of other countries (MOE, 2020). IAE had stated that TIMSS scale centre point is 500 points. However, a report from TIMSS 2015 showed that Malaysian students only scored 465 points, which is below the average score for TIMSS 2015 and has been classified to be at a low level (Yee, Tze, & Abdullah, 2017). Similarly, a report from TIMSS 2019 also showed that students' scores for Mathematics are still below the average score for TIMSS (MOE, 2020). The inconsistent performance of Malaysian students in mathematics from year 1999 to 2019 is shown in Figure 1.

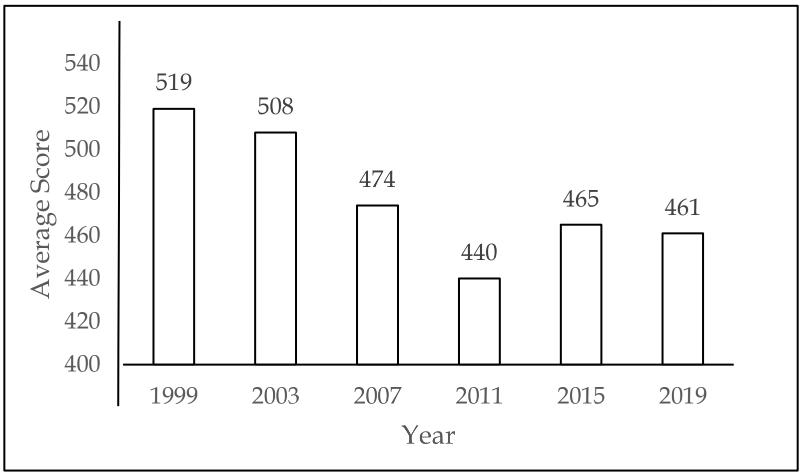

Figure 1: Students' Performance in Mathematics TIMSS 1999-2019

Geometry is a field in Mathematics that is related to shapes and properties (Crompton, Grant, & Shraim, 2018). It is one of the content domains in TIMSS where students are required to analyse various forms of geometry in 2-Dimension (2D) and 3-Dimension (3D). The report from TIMSS 2019 showed that the Malaysian students average score for Geometry is 466 points, which is below the international average score (MOE, 2020). The report also provided examples of students' performance in Geometry such as the ability to transform from 2D to 3D. The findings showed that only 42.2% students answered the question correctly. Another question asked them to determine an angle of an irregular rectangle, where only 52.1% of the students answered it correctly. These prove that students are having problems in learning Geometry (MOE, 2020).

On the contrary, certain topics in Geometry such as 3D is vital for high school students as they form the basis for their entrance requirements to register for university courses in science and technical fields (Shawky, Elbiblawy & Maresch, 2021). Besides, these topics also have a lot to do with students' real lives and their future careers (Gravemeijer et al., 2017). Thus, factors that influence students' performance in Geometry should be identified. One of the factors that contribute to low score in Geometry is poor visualization (Kmetová & Nagyová Lehocká, 2021). Padilla, Creem-Regehr, Hegarty and Stefanucci (2018) defined visualization as any information in visual form that is represented by graphics. Moreover, teaching strategies used by teachers in class also influence students in learning Geometry (Valtonen et al., 2017). Besides using textbook and marker board, most of the teachers use 3D models and draw 2D drawings of 3D objects in their teaching of 3D Geometry topics. However, both methods are considered ineffective as they are not sufficient to represent the 3D objects (Litoldo & Amaral-Schio, 2021). In fact, this mode of teaching has caused students to learn by memorizing the concepts of Geometry (Arifanti, 2020).

Previous studies had shown that, technology-based-learning had positive effects to students in schools (Azman et al., 2018; Balakrishnan et al., 2017; Huan Chin & Mohamed Noh, 2019; Yusoff, Puteh, & Amat Yasin, 2021; Gnanasagaran & Amat @ Kamaruddin, 2019; Madi, Albakry & Ibrahim, 2020; Yahya et al., 2018). Technology refers to an intention that are produced based on something that are designed or planned to fulfil a certain objective (Carroll, 2019). Technology can be classified into two forms: standard technology and digital technology (Mishra & Koehler, 2006). According to Mishra and Koehler, standard technology is non-digital things which are available for teachers such as whiteboard, chalks, and books, while the digital technology is anything that supports digital delivery such as computers, smart boards and the internet. Information, communication, and technology (ICT) is a form of digital technology which has been highlighted to be integrated in teaching and learning (MOE, 2012). However, a report from TIMSS 2019 revealed that 71% of mathematics teachers needed courses on how to integrate ICT in their lessons (MOE, 2020).

Therefore, visualization needs to be combined with technology in order to assist students in learning Geometry (Mavani, Mavani & Schäfer, 2018). In this study, visualization technology is defined as the technology that transforms nonvisual information into 2D or 3D imagery and aim to generate depictions of a certain phenomenon (Selkirk, 2019). However, there is a lack of teaching model that focuses on the integration of visualization technology in teaching Geometry. Hence, a teaching pedagogy model is needed for teachers. The purpose of this study is to investigate the need to adopt the integration of visualization technology and consequently the development of the pedagogical model of integration of visualization technology in mathematics (IViTeM) for secondary school teachers to enhance students' performance in Geometry.

Unified Theory of Acceptance and Use of Technology (UTAUT) Model

UTAUT model explains user intentions to use an information system (IS) and subsequent usage behavior. The theory posits that four key constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) are direct determinants of usage intention and behavior (Venkatesh, Morris, Davis & Davis, 2003). Based on the key constructs, the items for the questionnaire were divided into seven expectancies:

1) Performance expectancy – In this study, performance expectancy dealt with the extent of the effectiveness of visualization technology as a support in accommodating teachers' teaching needs. For example, how teachers perceive the usefulness of visualization technology in their teaching process to accomplish teaching tasks easily, and how visualization technology could improve students' performance in Geometry.
2) Effort expectancy – Effort expectancy is defined as the degree of ease in using visualization technology (Venkatesh et al., 2003).
3) Attitude toward using technology – This is defined as the teacher's overall affective reaction in using visualization technology (Venkatesh et al., 2003).

4) Social influence – Social influence is defined as the degree to which an individual perceives how important others believe he or she should use visualization technology (Venkatesh et al., 2003).
5) Facilitating conditions – Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of visualization technology (Venkatesh et al., 2003).
6) Self-efficacy – Self-efficacy deals with the teacher's individual perception on own ability and skills to use visualization technology.
7) Behavioral intention to use mobile learning – This deal with teachers' eagerness and intention to use visualization technology.

This model had been used by other researchers in doing need analysis phase such as Altalhi (2021) and Miranda Veiga and Valente de Andrade (2021).

Objective and Research Question

The objective of the study is to identify the needs of the development of pedagogical model of integration of visualization technology in mathematics (IViTeM) to enhance performance in Geometry based on teachers' views. Therefore, the needs analysis seeks to answer the following research questions:

a) What is the teachers' level of acceptance and intention to use visualization technology if incorporated into Mathematics, for the topic of Geometry?
b) Do teachers need pedagogical model of integration of visualization technology in mathematics (IViTeM)?
c) Is there any significant difference on level of acceptance and intention to use visualization technology between male and female teachers?

Research Hypotheses

H_1 There is a significant difference on performance expectancy between male and female teachers.
H_2 There is a significant difference on effort expectancy between male and female teachers.
H_3 There is a significant difference on attitude toward using technology between male and female teachers.
H_4 There is a significant difference on social influence between male and female teachers.
H_5 There is a significant difference on facilitating conditions between male and female teachers.
H_6 There is a significant difference on self-efficacy between male and female teachers.
H_7 There is a significant difference on behavioral intention between male and female teachers.

METHODOLOGY

This study is using Design and Development Research (DDR) approach that was proposed by Richey and Klein (2007). It consists of three phases: need analysis (Phase I); design and develop (Phase II), and evaluation (Phase III). This paper will only focus on Phase I. Needs analysis was conducted on the participants (mathematics teachers) to assess their needs to develop the visualization technology implementation model. Witkin (1997) defined needs analysis as a method to identify the gap between the current and targeted situation. McKillip (1987) on the other hand, stated that needs is a judgment value that a specific group has a problem, which needed to be solved. In this study, purposive sampling technique was used by researchers to select respondents with certain characteristics to get specific information from them (Palys, 2008). Therefore, the study involved a total of 60 teachers, where 30 were male and 30 were female. They were mathematics teachers from secondary schools in one of the states in Malaysia. The questionnaires were posed to the teachers to assess their need to have a teaching support in their teaching process as well as their level of acceptance on the incorporation of visualization technology into their current teaching of mathematics for Geometry and more importantly the degree of their intention to use visualization technology.

The instrument used for this study was a set of needs analysis survey questionnaire. The items for the survey questionnaire were constructed based on UTAUT model, a technology acceptance theory proposed by Venkatesh et al. (2003). The questionnaire consisted of 47 questions divided into five sections, A (respondent demography and their level of skills of using ICT), B (Teachers' perception on practice of teaching methods), C (Teachers' perception on teaching methods), D (Teachers' acceptance and intention to use visualization technology) and E (The need to develop the pedagogical model of integration of visualization technology in mathematics (IViTeM) to enhance performance in Geometry). Sections B, C and D, measured on a 7-point Likert scale (1: Strongly Disagree, 2: Disagree, 3: Somewhat Disagree, 4: Neutral, 5: Somewhat Agree, 6: Agree, 7: Strongly Agree).

Three curriculum and instruction technology experts were referred to validate the instrument. All of them are above 50 years old, with more than 20 years of teaching experience and they agreed to voluntarily participate in this study. Prior to this, appointment letters were sent out to these experts, followed by telephone calls and email correspondences, before appointments were made to meet them in person to hand out the validation forms as well as to brief them personally about IViTeM model. A period of two weeks was given for them to complete their validation reports. Reliability test was conducted on the survey questionnaire for all items, which registers a cronbach alpha coefficient of 0.926. A pilot study was conducted on 30 teachers from secondary schools using the instrument to improve the questionnaire items. The test obtained a reliability value of 0.823, which is considered 'very good'. However, the 30 teachers were not included in the actual needs analysis study. Data were analyzed using descriptive statistics via the Statistical Package for Social Science (SPSS) version 25 software. The main aim of the results of the data was to justify the need to develop the visualization technology implementation model.

RESULTS AND DISCUSSION

Demographic Profile

In this study, the sample consisted of 30 male teachers and 30 female teachers. Their demographic profile is shown Table 1. For level of education, 51 of them (85.0%) had degree and 42 of them (60.1%) had experienced more than 11 years in teaching mathematics. For skills in using ICT, 34 of the repondents (56.7 %) were at moderate level.

Table 1: *Respondent demographic profile (n = 60)*

		Frequency	Percentage
Level of Education	Degree	51	85.0
	Masters	8	13.3
	PhD	1	1.7
Experience in Teaching Mathematics	1-5 years	9	15.0
	6-10 years	9	15.0
	11-15 years	13	21.7
	16-20 years	10	16.7
	More than 20 years	19	31.7
Level of skills using ICT	Very Poor	0	0.0
	Poor	4	6.7
	Moderate	34	56.7
	Good	21	35.0
	Very Good	1	1.7

To answer research question 1 and 2, interpretation of mean is as shown in Table 2.

Table 2: Interpretation of Mean

Range of Scale	Interpretation of Mean
1.00 – 2.20	Very Low
2.21- 3.40	Low
3.41-4.60	Moderate
4.61-5.80	High
5.81-7.00	Very High

Source: Abdul Razak, Mohd Mahzan & Jamil (2017)

Research Question 1

What is the teachers' level of acceptance and intention to use visualization technology if incorporated into Geometry?

(1) Performance expectation

Performance expectancy deals with teachers' perception on the effectiveness of visualization technology as a support in accommodating teachers' teaching needs (Venkatesh, 2003). In this aspect, all means levels were high and the highest mean (M=5.70, SD=0.788) showed that the teachers agreed that visualization technology could increase their teaching performance as revealed in Table 3.

Table 3: Mean Score for Performance Expectancy

		Mean	**SD**	**Inter***
1	I feel that teaching Mathematics for the topic of Geometry using visualization technology is useful for my teaching.	5.58	0.809	H*
2	Using visualization technology in teaching of Mathematics for the topic of Geometry helps me facilitate the teaching and learning process more effectively.	5.55	0.852	H*
3	The application of visualization technology has been able to improve the quality of my teaching in Mathematics for the topic of Geometry.	5.68	0.833	H*
4	My teaching performance will be better in Mathematics for Geometry topics by using visualization technology.	5.70	0.788	H*
	Overall	5.63	0.821	H*

Inter*= Interpretation of the mean, H*= High

(2) Effort Expectancy

Venkatesh (2003) defines 'Effort expectancy' as the degree of ease in using a proposed system; in this study, the system is visualization technology. From Table 4, the level of all means was high. The highest mean (M=5.60, SD=0.807) indicated that teachers agreed that visualization technology can make their teaching easy for students to understand the concepts of Geometry.

Table 4: Mean Score for Effort Expectancy

		Mean	**SD**	**Inter***
1	My interaction in teaching of Mathematics for the topic of Geometry using visualization technology will be easier to understand.	5.60	0.807	H*
2	The use of visualization technology makes it easier for me to become more proficient in teaching Mathematics for the topic of Geometry	5.58	0.907	H*
3	I found that teaching Mathematics for the topic of Geometry using visualization technology is easy to be used.	5.48	0.911	H*
	Overall	5.55	0.875	H*

Inter*= Interpretation of the mean, H*= High

(3) Attitude Toward Using Technology

Attitude expectancy concerns the student's overall affective reaction to use visualization technology (Venkatesh et al., 2003). In terms of this aspect, the level of all means was high and the highest mean (M=5.75, SD=0.836) showed that visualization technology can make their lesson more fun as shown in Table 5.

Table 5: Mean Score for Attitude Toward Using Technology

		Mean	SD	Inter*
1	I do not like to use visualization technology in teaching Mathematics for the topic of Geometry.	4.88	1.34	H*
2	Teaching Mathematics using visualization technology makes the lesson more interesting.	5.68	0.770	H*
3	Teaching Mathematics using visualization technology for the the topic of Geometry is more fun	5.75	0.836	H*
4	Using visualization technology during Mathematics learning sessions for Geometry topics is a good thing.	5.67	0.857	H*
	Overall	5.50	0.951	H*

Inter*= Interpretation of the mean, H*= High

(4) Social Influence

Social influence is defined as the degree to which an individual perceives that people who are important to them believe they should use visualization technology (Venkatesh et al., 2003). In this aspect, the overall findings showed that people who are important or having influence on the respondents' behavior did have a significant effect on their motivation in deciding to use visualization technology. In Table 6, all means for the items were high and the highest mean (M=5.23, SD=1.25) showed that the administrator plays an important role to motivate teachers to use visualization technology.

Table 6: Mean Score for Social Influence

		Mean	SD	Inter*
1	My friend will influence me to use visualization technology in teaching of Mathematics for topic of Geometry	4.95	0.98	H*
2	My friend encouraged me to use visualization technology in teaching of Mathematics for the topic of Geometry	5.10	1.07	H*
3	The administrator encouraged me to use visualization technology in teaching of Mathematics for topic of Geometry.	5.23	1.25	H*
4	The school has provided support for the use of visualization technology in teaching of Mathematics for the topic of Geometry	5.22	1.22	H*
	Overall	5.13	1.132	H*

Inter*= Interpretation of the mean, H*= High

(5) Facilitating Conditions

Facilitating conditions on the other hand are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of visualization technology (Venkatesh et al., 2003). In this aspect, the overall findings indicated significant positive result on the teachers' perception on the organizational and technical support on their use of visualization technology as shown in Table 7. However, the level of mean for item 2 is moderate (M=4.57, SD=1.16). Thus, teachers need more knowledge on using visualization technology in teaching.

Table 7: Mean Score for Facilitating Conditions

		Mean	SD	Inter*
1	I have tools and resources needed to use visualization technology in teaching of Mathematics for the topic of Geometry	4.75	1.31	H*
2	I have the necessary knowledge to use visualization technology in teaching of Mathematics for the topic of Geometry	4.57	1.16	M*
3	I have someone to refer to if I have trouble using visualization technology in teaching of Mathematics for the topic of Geometry.	4.67	1.41	H*
	Overall	4.66	1.292	High

Inter*= Interpretation of the mean, H*= High, M*=Moderate

(6) Self-Efficacy

Self-efficacy deals with the student's individual perception of his or her own ability and skills to use visualization technology. This aspect perhaps is one of the most important aspects in determining their readiness to use visualization technology. The average mean for all items (4.99) indicated that the level was high as shown in Table 8. However, the first item revealed that the level of mean is moderate (M=4.48, SD=1.47). Hence, teachers need guidance on using visualization technology in teaching.

Table 8: Mean Score for Self-Efficacy

		Mean	SD	Inter*
1	No one told me what to do	4.48	1.47	M*
2	There is someone I can refer to for help when I am in trouble	5.08	1.23	H*
3	If I have the resources available and a lot of time.	5.25	1.11	H*
4	There are facilities needed for teaching.	5.13	1.13	H*
	Overall	4.99	1.233	H*

Inter*= Interpretation of the mean, H*= High, M*=Moderate

(7) Behavioral Intention

This aspect deals with teachers' eagerness and intention to use visualization technology. Table 9 indicates that the level of all means was high and the highest mean (M=5.57, SD=1.015) showed that the teachers planned to use visualization technology the soonest possible.

Table 10: Mean Score for Behavioral Intention

		Mean	SD	Inter*
1	I intend to use visualization technology in teaching Mathematics for the topic of Geometry as soon as possible.	5.57	1.015	H*
2	I plan to use visualization technology in teaching Mathematics for the topic of Geometry in the next two months	5.30	1.139	H*
3	I expect I will use visualization technology in teaching Mathematics for the topic of Geometry in in the near future.	5.15	1.176	H*
	Overall	5.34	1.11	H*

Inter*= Interpretation of the mean, H*= High

As a conclusion, teachers' level for each constructs were analysed. The finding showed that all constructs (performance expectancy (M=5.63, SD=0.821), effort expectancy(M=5.55, SD=0.875), attitude toward technology(M=5.50, SD=0.951), social influences(M=5.13, SD=1.132), facilitating conditions (M=4.66, SD=1.292), self-efficacy(M=4.99, SD=1.233) and behavirol intention (M=5.34, SD=1.11)) were high. The findings were in line with a study conducted for primary school teachers (Farid Helmi, 2019) and secondary school teachers (Mohd Paris, 2016) using UTAUT that showed all levels of constructs were high.

Research Question 2

Do teachers need pedagogical model of integration of visualization technology in mathematics (IViTeM)?
Table 10 indicates that majority of the teachers (63.3%) referred to pedagogical model and technology model for improving the teaching of Geometry. Besides that, majority of them (61.7%) had never heard of the pedagogical model that integrates visualization technology in Geometry. However, majority of the teachers (90.0%) agreed that there is a need to develop this pedagogical model of IViTeM. Moreover, majority of them (63.3%) agreed that they did not have enough material to use this pedagogical model of IViTeM. Findings are supported by Christopoulos and Sprangers (2021), who studied the integration of technology among teachers during Covid-19 pendamic. They found out that teachers need support on selections of online tools to engage students in learning.

Table 10: The need to develop the IViTeM model

		Y	N
1	Have you ever referred to any pedagogical model for improving teaching of Geometry in secondary school?	38 (63.3%)	22 (36.7%)
2	Have you ever referred to any technology model for improving teaching of Geometry in secondary school?	38 (63.3%)	22 (36.7%)
3	Have you ever heard of the pedagogical model of integration of visualization technology in Mathematics?	23 38.3%	37 (61.7%)
4	Do you feel the need to develop a pedagogical model of integration of visualization technology in Mathematics for the topic of Geometry?	54 (90.0%)	6 (10.0%)
5	Do you have enough material to use the pedagogical model of integration of visualization technology in Mathematics for the topic of Geometry in school?	22 (36.7%)	38 (63.3%)

Research Question 3

Is there any significant difference on level of acceptance and intention to use visualization technology between male and female teachers?

Table 11 shows the hypotheses that had been tested in the study, while Table 12 shows the value of effect size as suggested by Cohen (1988). The findings revealed that on the basis of gender, men have higher overall score than women. In addition, from the t-test, it is found that the differences presented in performance expectancy (H1) and social influence (H3) were found to be significant. For H1, there was a significant difference in male teachers' and female teachers' performance expectancy (M=5.85, SD=0.72) and (M=5.41, SD=0.65), respectively, with t (58) = 2.40, p=0.02. The effect size is large according to Cohen (1988). Meanwhile, for H3, there was a significant difference in social influence for male teachers (M=5.38, SD=0.83) and female teachers (M=4.86, SD=0.90), t (58) = 2.31, p=0.03. The effect size is large according to Cohen (1988). These findings are in accordance with that of the prior study by Romero-Rodríguez, Alonso-García, Marín-Marín and Gómez-García (2020), who had applied the UTAUT model and in which gender was presented as an influential factor. Similarly, Katerina & Nicolaos (2018) revealed that technology integration is more challenging for females than males. Thus, it is crucial to take gender into account when visualization technology is integrated in the classroom.

Table 11: Summary of the results for t-test

Hypotheses	Male		Female		t*	p*	HT*	d
	Mean (n=30)	SD	Mean (n=30)	SD				
H1: Performance Expectancy	5.85	0.72	5.41	0.65	2.40	0.02	Y*	0.64
H2: Effort Expectancy	5.73	0.80	5.37	0.78	1.73	0.09	N*	0.46
H3: Attitude Toward Using Technology	5.68	0.63	5.38	0.65	1.79	0.08	N*	0.47
H4: Social Influence	5.38	0.83	4.86	0.90	2.31	0.03	Y*	0.60
H5: Facilitating Conditions	4.75	1.08	4.56	0.95	0.71	0.48	N*	0.19
H6: Self-Efficacy	4.93	0.87	5.04	0.68	-0.53	0.60	N*	0.14
H7: Behavioral Intention	5.45	1.03	5.22	0.92	0.92	0.36	N*	0.24

Y*=Supported for hypothesis, where $p< 0.05$, N*=no support for hypothesis, HT = Hypothesis testing, d = Cohen's d value, t* = t value, p*=p value.

Table 12: Criteria for effect size

Value of d	Criteria
$0< d < 0.2$	Small
$0.2 < d < 0.5$	Medium
$0.5 < d < 0.8$	Large
$d > 0.8$	Very large

Source: Cohen (1988)

CONCLUSION

The purpose of this study is to examine the acceptance and expectation of teachers towards visualization technology through its incorporation into Mathematics for the topic of Geometry at secondary schools. In addition, this study examined UTAUT constructs according to genders. A positive response from the teachers would justify the need to develop a visualization technology implementation pedagogical model as suggested in this study. According to the findings on teachers' acceptance and intention to use visualization technology, the overall result on all the key constructs (based on UTAUT model) concluded that the teachers highly accepted visualization technology as intervention in facilitating their teaching needs – and they intended to use it. The findings also suggested that gender is a factor that influenced the designed of this model. It showed that gender plays significance role in teachers' Performance Expectancy and Social Influence. Furthermore, these findings will be used to form questionnaires for survey purposes in phase two of the bigger study to gather experts' opinions via Delphi technique. Mathematics curriculum for secondary level would then be developed based on results from phase two. The developed curriculum would then enter phase three of the study for evaluation. Education stakeholders, policy makers, teachers, researchers and private sectors could benefit from this study especially in gaining some insights into the needs of visualization technology curriculum in schools and other learning institutions as a guide to set up relevant infrastructures, selection of devices and learning content, management of learning system, or skills and form of training needed for instructors.

ACKNOWLEDGEMENTS

This research was supported by Ministry of Higher Education through Fundamental Research Grant Scheme (RACER/1/2019/SSI09/UPSI//3).

REFERENCES

Abdul Razaq Ahmad, Mohd Mahzan Awang & Jamil Ahmad (2017). Aspirasi Terhadap Kepimpinan Politik Negara. *Malaysian Journal of Youth Studies*, 16,19-47.

Altalhi, M. (2021). Towards understanding the students' acceptance of moocs: A unified theory of acceptance and use of technology (utaut). *International Journal of Emerging Technologies in Learning (iJET)*, 16 (2), 237-253.

Arifanti, D. R. (2020). Mathematical reasoning in problem-solving in three dimensions. *Journal of Physics: Conference Series*, 1613(1) doi:http://dx.doi.org.ezpustaka2.upsi.edu.my/10.1088/1742-6596/1613/1/012077

Azman, M. N. A, Parmin, A.M.S, Balakrishnan, B. Yaacob, M. I. H., Baharom, S., Mohd Zain, H. H, Abdul Muthalib, F. H. & Samar, N. (2018). Retooling science teaching on stability topic for stem education: Malaysian case study. *Journal of Engineering Science and Technology*, 13(10), 3116 – 3128.

Balakrishnan, B., Chong, H.B, Idris, M. Z., Othman, A. N., Wong, M. F. & Azman, M. N. A. (2017) Improving the English literacy skills of Malaysian dyslexic children: The case of culturally responsive mobile multimedia tool, *Geografia-Malaysian Journal of Society and Space*, 11 (13), 49-59.

Carroll, L. S. L. (2017). A comprehensive definition of technology from an ethological perspective. *Soc. Sci*. 6 (126): 1-20; doi:10.3390/socsci6040126

Christopoulos, A. & Sprangers, P. (2021) Integration of educational technology during the Covid-19 pandemic: An analysis of teacher and student receptions, *Cogent Education*, 8(1), 1964690, DOI: 10.1080/2331186X.2021.1964690

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.

Crompton, H., Grant, M. R., & Shraim, K. Y. H. (2018). Technologies to Enhance and Extend Children's Understanding of Geometry: A Configurative Thematic Synthesis of the Literature. Educational Technology & Society, 21 (1), 59–69.

Farid Helmi Mohamad Noor (2019). Penerimaan dan penggunaan 'Blended Learning' dalam kalangan guru sekolah rendah. Unpublished Theses: UPSI.

Gnanasagaran, D., & Amat @ Kamaruddin, A. H. (2019). The effectiveness of mobile learning in the teaching and learning of probability. Jurnal Pendidikan Sains Dan Matematik Malaysia, 9(2), 9-15. https://doi.org/10.37134/jpsmm.vol9.2.2.2019

Gravemeijer, K., Stephan, M., Julie, C., Lin, F. L., and Ohtani, M. (2017). What Mathematics Education May Prepare Students for the Society of the Future? *International Journal of Science and Mathematics Education*, *15*(2017), 105–123. https://doi.org/10.1007/s10763-017-9814-6.

Huan chin, K., & Mohamed Noh, N. (2019). The effectiveness of the use of interactive whiteboard in malay language learning among year 3 students (11-17). *Jurnal Pendidikan Bitara UPSI*, 9(2), 11-17. Retrieved from https://ejournal.upsi.edu.my/index.php/JPB/article/view/2469.

Katerina, T., & Nicolaos, P. (2018). Examining gender issues in perception and acceptance in web-based end-user development activities. Education and Information Technologies, 23(3), 1175-1202. doi:http://dx.doi.org/10.1007/s10639-017-9650-x

Kementerian Pendidikan Malaysia (2020). *Laporan Kebangsaan TIMSS 2019 - Trends in International Mathematics and Science Study*. Kementerian Pendidikan Malaysia: Putrajaya.

Kementerian Pendidikan Malaysia. (2012). *Pelan Pembangunan Pendidikan Malaysia (PPPM) 2013 – 2025.* Putrajaya: Kementerian Pendidikan Malaysia.

Kmetová, M., & Nagyová Lehocká, Z. (2021). Using Tangram as a Manipulative Tool for Transition between 2D and 3D Perception in Geometry. *Mathematics, 9*(18), 2185. MDPI AG. Retrieved from http://dx.doi.org/10.3390/math9182185

Litoldo, B. F. & Amaral-Schio, R. B. (2021). Universidade Estadual PaulistaMathematics textbooks as subject of study: Producing knowledge on the presence of geometry, *The Mathematics Enthusiast*, 18(3), 502-534.

Madi, N. M., Albakry, N. S. & Ibrahim, N (2020), AR Mobile Application in Learning Hajj for Children in Malaysia: A Preliminary Study, *International Journal of Interactive Mobile Technologies*, 14(16), 35-51.

Mavani, D., Mavani,B. & Schäfer, M. (2018). A Case Study of Two Selected Teachers as they Integrated Dynamic Geometry Software as a Visualisation Tool in Teaching Geometry, African Journal of Research in Mathematics, Science and Technology Education, 22(3), 297-307. DOI: 10.1080/18117295.2018.1522716

McKillip, J. (1987). Need Analysis: tools for the human services and education. Newbury Park, CA: Sage.

Miranda Veiga, F. J. & Valente de Andrade, A. M. (2021). Critical Success Factors in Accepting Technology in the Classroom. *International Journal of Emerging Technologies in Learning (iJET)*, 6 (18), 4-22.

Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. Teachers College Record 108 (6), 1017-1054.

Mohd Paris Saleh (2016). Model pengajaran m-pembelajaran berasaskan kaedah inkuiri mata pelajaran sejarah peringkat menengah. Unpublished Theses: UM.

Padilla, L. M. , Creem-Regehr, S.H., Hegarty, M. & Stefanucci. J. K. (2018). Decision making with visualizations: a cognitive framework across disciplines. *Cognitive Research: Principles and Implications*, 3(29), 1-25. https://doi.org/10.1186/s41235-018-0120-9.

Palys, T. (2008). Purposive sampling. In L.M. Given (Ed.) The Sage Encyclopedia of Qualitative Research Methods. (Vol.2).Sage: Los Angeles, pp. 697-8.

Romero-Rodríguez J-M, Alonso-García S, Marín-Marín J-A, Gómez-García G. (2020). Considerations on the Implications of the Internet of Things in Spanish Universities: The Usefulness Perceived by Professors. *Future Internet*,12(8):123. https://doi.org/10.3390/fi12080123.

Richey, R. C., & Klein, J. D. (2007). *Design and Development Research: Methods, strategies and issues*. London: Erlbaum.

Selkirk, K. (2019). Seeing and Believing:Examining The Role Of Visualization Technology In Decision-Making About The Future. Dissertation for the Degree Doctor of Philosophy. Arizona State University.

Shawky, A., Elbiblawy, E. & Maresch, G. (2021). Spatial ability differences between students with a math learning disability and their other normal colleagues. *Journal of Humanities and Applied Social Sciences*, 3 (3), 182-198.

Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., Lambert, M. C., and Mäkitalo-Siegl, K. (2017). TPACK updated to measure pre-service teachers' twenty-first century skills. *Australasian Journal of Educational Technology*, *33*(3). https://doi.org/10.14742/ajet.3518.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Witkin, B.R. (1997). Needs assessment kits, model and tools. Educational Technology, 17(11), 5-18

Yee, C. S., Tze, W. J., and Abdullah, A. H. (2017). Pencapaian matematik TIMSS 1999, 2003, 2007, 2011 dan 2015: Di manakah kedudukan Malaysia dalam kalangan Negara Asia Tenggara? *Malaysian Journal of Higher Order Thinking Skills in Education (MJHOTS)*, 54–109.

Yusoff, N., Puteh, M., & Amat Yasin, A. (2021). Needs Analysis for Online Game Development for Form 2 Mathematics in the District of Bagan Datuk, Perak. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, 11, 29-38. https://doi.org/10.37134/jpsmm.vol11.sp.3.2021