DEVELOPMENT OF AN INSTRUMENT TO MEASURE THE ACCEPTANCE OF SECONDARY SCHOOL TEACHERS TOWARDS THE USAGE OF MATHEMATICS MOBILE APPLICATIONS

GAYATIRI A/P BALASUBRAMANIAM

UNIVERSITI PENDIDIKAN SULTAN IDRIS

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ABSTRACT

The purpose of this exploratory mixed-methods research is to develop and validate an instrument for the factors that impact the Mathematics teacher's acceptance of using the Mathematics Mobile Applications (MMA) and to identify the Mathematics teacher's acceptance level of using the MMA. The constructs and items of the instrument were developed through a literature review and an interview session. Six constructs, namely Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Self-Motivation (SM), and Students Engagement (SE), were discovered. The face validity and content validity of the instrument were validated by three and nine experts, respectively. 552 secondary school teachers from Perak participated in this survey using the MMA instrument. The survey data were analyzed using Rasch analysis and SPSS 29. The findings indicated that all the items developed were within the infit and outfit MNSQ of PSA of 0.63 to 1.40 logits. In terms of unidimensionality, the eigenvalue of the first construct is 8.3, which proves that MMA's instrument is multidimensional and supports the six constructs that emerged from the literature review and interview findings. Employing SPSS 29 revealed that there is a high level of teachers' acceptance of using the MMA, with mean values ranging from 3.6273 to 4.7919 and standard deviation values ranging from 0.68621 to 0.78742. As a conclusion, this study has developed an instrument to measure the acceptance of secondary school teachers' towards the usage of Mathematics Mobile Applications.

PEMBANGUNAN INSTRUMEN APLIKASI MUDAH ALIH MATEMATIK (MMA) TERHADAP PENERIMAAN GURU SEKOLAH MENENGAH

ABSTRAK

Tujuan kajian ini adalah untuk membangunkan dan mengesahkan instrumen bagi faktor-faktor yang memberi impak kepada penerimaan guru Matematik terhadap penggunaan aplikasi mudah alih Matematik (MMA) dan mengenal pasti tahap penerimaan guru Matematik dalam penggunaan MMA. Konstruk dan item instrumen diperoleh daripada tinjauan literatur dan temubual. Enam konstruk iaitu, Jangkaan Prestasi (PE), Jangkaan Usaha (EE), Pengaruh Sosial (SI), Keadaan Memudahcara (FC), Motivasi Kendiri (SM) dan Penglibatan Pelajar (SE) adalah hasil tinjauan literatur dan temubual. Sebanyak 552 guru sekolah menengah dari Perak telah menjawab instrumen ini. Data ini dianalisis dengan menggunakan analisis Rasch dan SPSS 29. Dapatan analisis Rasch menunjukkan bahawa semua item yang dibangunkan berdasarkan konstruk dalam MNSQ infit and outfit PSA adalah sebanyak 0.63 hingga 1.40 logit. Dari segi unidimensi, nilai eigen bagi konstruk pertama ialah 8.3 yang menunjukkan bahawa instrumen MMA adalah multidimensi dan menyokong enam konstruk yang diperoleh daripada dapatan temu bual. Keputusan SPSS 29 menunjukkan tahap penerimaan guru yang tinggi untuk menggunakan MMA. Hal ini dibuktikan dengan nilai min antara 3.6273 hingga 4.7919 dan nilai sisihan piawai dari 0.68621 hingga 0.78742. Secara kesimpulan, kajian ini telah berjaya membangunkan instrumen untuk mengukur tahap penerimaan guru sekolah menengah terhadap penggunaan aplikasi mudah alih matematik.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASEAN	Association of South-East Asian Nations
CAPs	Critical Agenda Projects
CAS	Computer Algebra Systems
C-TAM-TPB	Combined TAM and TPB
CTT	Classical Test Theory
DGS	Dynamic Geometry Systems
DIF	Differential Item Functioning
EE	Effort Expectancy
EPRD	Educational Planning and Research Division
ERME	Extension Risk Management Education
FC	Facilitating Conditions
HCI	Human-Computer Interaction
ICT	Information and Communications Technology
I-CVI	Content Validity Index
IDT	Innovation Diffusion Theory
IRT	Item Response Theory
IS	Information System
JPN	State Education Officers
KRA	Key Result Areas
LMS	Larut Matang dan Selama

Logit	Log Odd Unit
M-learning	Mobile Learning
MM	Motivational Model
MMA	Mathematics Mobile Applications
MMR	Mixed Method Research
MnSq	Mean Square
MOE	Ministry of Education
MoMT	Mobile Mathematics Tutoring
MPCU	Model of PC Utilization
NCTM	National Council of Teachers of Mathematics
PCA	Principal Components Analysis
PE	Performance Expectancy
PIBG	Parents and Teachers Association
PLC	Professional Learning Community
PPD	District Education Officers
SCT	Social Cognitive Theory
S-CVI	Content Validity Scale
SE	Students Engagement
SI	Social Influence
SM	Self-Motivation
SME	Subject Matter Experts
T1	Teacher 1
T2	Teacher 2
T3	Teacher 3

T4	Teacher 4
T5	Teacher 5
T6	Teacher 6
T7	Teacher 7
T8	Teacher 8
T9	Teacher 9
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TWG	Tools and Technologies in Mathematical Didactics
UB	User Behaviour
UTAUT	Unified Theory of Acceptance and Use of Technology
Zstd	Z standard

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The goal of learning in global education systems has shifted. Information and Communications Technology (ICT) has grown rapidly among educational scholars in recent decades and it has the potential to revolutionise education (Das, 2019; Verschaffel et al., 2019). Computers were first utilised in classrooms in the early 1980s, and numerous academics believe that ICT will be a significant aspect of education for the next generation (Ghavifekr et al., 2016; Nurfakhrana et al., 2019). Many different strategies for classroom teaching and learning are available with today's technology. According to Verschaffel et al. (2019), new technologies offer the potential to improve education across the curriculum and provide chances for effective student-teacher collaboration in ways that were previously unavailable.

ICT can provide an engaging and effective teaching and learning environment. Teachers must include ICT in their normal instruction and replace traditional tactics with modern tools and facilities as the digital era progresses (Ghavifekr et al., 2014; Namome & Moodley, 2021). This demonstrates that educators, particularly teachers, must comprehend, embrace, and adopt changes, innovations, and applications in today's education to provide students with the most up-to-date, smarter educational environment. The vast majority of people now have access to readily available computers at reasonable prices, whether at home or school, and policymakers and other key stakeholders are expressing optimism that learning will take a new direction (Ghavifekr et al., 2016; Halili & Sulaiman, 2019; Kramarenko et al., 2021).

Perienen (2020) found plenty of studies demonstrating kids learn Mathematics more effectively and appropriately when technology is integrated into teaching and learning. The findings suggest that more tangible encouragement, support, and opportunities for teachers to boost their motivation and hence the level and quality of ICT used in classrooms should be provided (Halili & Sulaiman, 2019; Kramarenko et al., 2021). Technology integration was investigated by Perienen (2020), which found that teachers' attitudes towards technology and willingness to employ technology were important elements. Teachers help pupils learn knowledge by channelling and facilitating it, as well as triggering their creative minds following the curriculum. Sattarov and Khaitova (2019) state that, Mobile learning (M-learning) is becoming a strategic priority for many educational institutions.

M-learning refers to learning that takes place on the Internet and mobile devices such as smartphones, personal digital assistants, cell phones, tablets, and laptops

(Drigas & Pappas, 2015; Darmaji et al., 2019). It demonstrates how mobile devices facilitate anytime and everywhere learning. It also gives students access to learning resources outside of the classroom and school. M-learning allows students to interact with their learning resources even when they are not in their usual learning environments (Kumar Basak et al., 2018; Qureshi et al., 2020). Since, new types of devices and applications are revolutionising education, ensuring that M-learning is appropriately used and applied is essential.

As technology plays a vital role in knowledge acquisition, content assimilation and understanding, teachers' technological competency, thus their ability to meet the developing learning styles of digital natives, is becoming increasingly important (Al-Hunaiyyan et al., 2018; Perienen, 2020) The advancement of wireless technology in education, as well as the creation of mobile applications, has been remarkable. Many secondary schools and higher education teachers have found that mobile technology in education has become one of the most important areas of research and application in recent years (Al-Hunaiyyan et al., 2018; Kumar Basak et al., 2018). In addition, a wide range of multimedia applications, including mobile learning applications, have been developed expressly for teaching and learning (Ibrahim, 2017; Sattarov & Khaitova, 2019). As a result, mobile devices can be used for education. Over the past years, researchers have focused on the use of technology in Mathematics education.

The National Council of Teachers of Mathematics (NCTM) in the United States regards technology to be important in teaching and studying Mathematics (Fabian et al., 2018). It also noted that appropriate and effective use of technology enables learning situations that improve Mathematics enjoyment. They also, however, say that the

impacts differed depending on the sort of educational technology employed. In recent years, mobile devices have been more widely accepted in education. These technologies have been implemented in the classroom through school and government initiatives. Some of the possible benefits of using mobile technologies for learning include facilitating learning across contexts, contextual learning, and personalisation in both personal and collaborative situations (Fabian et al., 2018; Rusdi et al., 2020). Mobile technology appears to be an effective tool for learning Mathematics because of these benefits. Most of these technologies merge with the Malaysian curriculum.

In the Malaysian Mathematics curriculum, there are five main domains; Numbers and Operations, Correlation and Algebra, Statistics and Probabilities, Measurement and Geometry, and Discrete Mathematics (Curriculum, 2019). There are a variety of online and mobile applications available today to facilitate the teaching of these areas of Mathematics. Many researchers have undoubtedly created online and mobile applications to aid in the teaching and learning of Mathematics topics like Algebra, Geometry, Mathematical Analysis, and Statistics. Mobile math, for example, allows users to study functions using graphical capabilities and particular calculators.

Similarly, some measurement applications like AirMeasure, Angle Meter 360° and Ruler AR improve measurement tasks by allowing users to practise their numerical and Mathematical skills. In addition, recently, technologies that support Mathematics on the web have increased in popularity (Darmaji et al., 2019; Drigas & Pappas, 2015). Therefore, this study initiates an instrument development to measure the use of Mathematics Mobile Applications (MMA) in teaching and learning Mathematics. The available MMA's such as Mobile Math, Math4Mobile, Sketch2Go, Graph2Go, Fit2Go

and Mobile Mathematics Tutoring (MoMT) can only be engaged in teaching and learning Mathematics if and only the teachers understand and accept the usage of these applications. The use of the MMA is essential for the teachers as the majority of MMA engaged students, making Mathematics classes more entertaining and interactive than traditional classroom instruction (Al-Takhyneh, 2018; Etcuban & Pantinople, 2018). Therefore, a rigorously validated instrument will measure the teacher's acceptance of using MMA in teaching and learning Mathematics.

1.2 Background of Study

Teaching is a method of learning knowledge. It entails activities such as information or knowledge transformation, task completion, and knowledge and belief enrichment through interactions between teachers and students. According to Adedeji (2018), there are three types of teaching: rational, strategic, and institutional. He states that explaining, inferring, concluding, and offering evidence are examples of logical acts. This is a content-based element of teaching while motivating, encouraging, praising, and disciplining are examples of strategic acts.

Mathematics education is known as the procedure meant to provide teachers with the knowledge, attitudes, behaviours, and abilities they need to perform their responsibilities effectively in the school and classroom (Adedeji, 2018; Chao et al., 2018). Besides, Mathematics education is crucial because no country can achieve a high level of education unless the quality of the teachers improves (Planas et al., 2018; Sessa, 2018). A teacher's ability to teach is determined by his or her preparedness for the job

of a distinct practitioner. In the teaching profession, the teacher is a vital component of any educational system's success.

Perienen (2020) described minimal pedagogical change, and low-level use, in which only fundamental procedures such as Internet information search, presentation programmes, and other application programmes are used to enhance teaching techniques. This study evaluates teachers' ease of use and usefulness of computers, as well as other factors such as application competency, behaviour, readiness and ICT facilities that may have an impact on technology usage, given the pervasiveness of computers and their capacity to influence learning.

There were two requirements for the integration of technology into the process of education and learning at the very beginning of the 21st century. To achieve important and interesting study findings in "real" classroom settings, there was a call for longer-term, more sustained programmes (Trgalová et al., 2018). On the other side, connectivity-related issues started to surface, such as how to link pupils and Mathematics through technology, teachers and pupils, and technology with other tools for teaching and learning. This emphasises how crucial it is to integrate technology into the full range of resources offered to students, teachers, and teacher educators (Hassan et al., 2019).

Given the great excitement for the new opportunities that computers and technology were going to open up for Mathematics and Mathematics education a decade ago, Trgalová et al. (2018) noted that researchers gave a depressing image of the current scenario regarding the distribution of technology. Despite a large number of

research studies and accounts of classroom practises, the impact of technology on curriculum and assessment change in Mathematics education is still limited (Hassan et al., 2019). Since effective use of technological tools requires the purposeful creation of relevant issues, the world is now focusing on the fundamental characteristics of Mathematical digital tasks, as well as features of their design and implementation for Mathematical learning.

In order to fulfil the needs of today's education with emerging technology, Malaysia has made great progress in terms of education. The Malaysian Education Blueprint 2013-2025 was designed and launched by the MOE to improve the quality of education in Malaysia. It intends to reform the Malaysian education system to compete with the developing international education system. The MOE has highlighted 11 modifications that could lead to changes in the Malaysian education system to attain this goal. This shows that MOE is pursuing the nation through the technology education system and students from all age groups are getting ready for this transformation. The first step in the action plan is to ensure that everyone has equal access to high-quality education based on an international standard (Malaysian Education Blueprint, 2013-2025).

The practice of mobile learning or M-learning enables rapid growth in the education system. However, the practice of M-learning is still a dilemma for teachers as they need to convert their usual teaching strategies (Al-Hunaiyyan et al., 2018). According to Mutambara and Bayaga, (2020), more studies on the adoption of this, particularly on teacher acceptance are needed for M-learning to be successfully adopted. Studies have proven that this learning can help students overcome obstacles

in classes (Li et al., 2020; Mutambara & Bayaga, 2020). M-learning needs to be improved even in remote regions, with the arrival of mobile broadband, and therefore fast and dependable internet connection will be made available. Data bundles will be made more affordable, making M-learning more accessible in rural regions.

Besides that, M-learning shifts the focus from the teacher to the student, which can lead to deeper, more holistic learning experiences (Mutambara & Bayaga, 2020; Qureshi et al., 2020). It also provides teachers with a variety of teaching approaches, including the use of audio recording features, live polling tools, chat, online discussion forums, and group work. Learners use this learning style to visualise Mathematical solutions, which help them increase their knowledge and deliver thorough explanations of the specified topics. M-learning gives learning material everywhere and at any time and reduces time lost by increasing the contact time between teachers and students. Al-Hunaiyyan et al., 2018 and Mutambara and Bayaga, 2020, also states that mobile devices are inexpensive and may be utilised as a cognitive tool in learning tasks to solve real-world problems and encourage reflection and collaboration during the learning process. We can conclude that, despite the problems that today's education has, M-learning can be used to assist students in acquiring all the skills that will prepare them for their future jobs (Qureshi et al., 2020).

In the epoch of technologization, mobile applications play a vital role in conducting M-learning. When compared to textbooks, mobile applications aided students' judgments of the value of identification in learning. As a result, interactive Mathematical models of Mathematics mobile applications on mobile devices that use web services could make learning more accessible to everyone (Alkhateeb & Al-

Duwairi, 2019; Supandi et al., 2018). Some games, for example, have been infused with instructional content and have Mathematics as their central topic. The game may appear simple, but it poses a challenge for users or students who are only learning the fundamentals of Mathematics while also having fun at once (Taufiq et al., 2019).

1.3 Problem Statement

Since the millennium, every youngster had the internet as a continuous companion and there is no way to avoid technological advancements. Technology has been incorporated into the classroom environment as it has grown more widespread. Many schools utilise computers and tablets in the classroom and assign homework that includes educational applications. Although the use of technology in today's education is growing in popularity, "Is application-based learning genuinely benefiting students" is one of the frequently asked questions. There are a few issues in using mobile applications in the education system.

Despite the growing popularity of MMA, Hew (2017) and Papadakis et al., (2021), claim that there is little study on teachers' and students' opinions toward the MMA. Furthermore, due to the continuous growth of the MMA market; there is still a lack of discussion on the individuals' behaviour in the adoption and continued usage of MMA. In truth, Hew (2017) and Papadakis et al., (2021), state that although the research on MMA acceptance and adoption is minimal, it is expanding. However, the move from traditional education to ICT-enhanced environments is not easy, and many

teachers are still apprehensive about using technology, particularly MMA, in their classrooms (Ghavifekr et al., 2016; Papadakis et al., 2021).

The majority of previous research has been conducted in the contexts of undergraduates or university instructors. The effects of using mobile applications on students' achievements also have been discussed (Alkhateeb & Al-Duwairi, 2019; Fabian et al., 2018; Rozgonjuk et al., 2020). So far, there is less research that has been conducted to determine whether school teachers are willing to use MMA (Hew, 2017; Papadakis et al., 2021),. Since the culture and environment of teaching and learning in universities and schools differ in terms of subjects, syllabuses, pedagogical approaches, levels of instruction, assessment and evaluation, education administration, organisational structure, and so on, the findings may not be comparable or applicable to the school context, necessitating a study of the MMA from the perspective of school teachers (Alkhateeb & Al-Duwairi, 2019; Hew, 2017). Besides, the goal of all these studies was to figure out what elements affect MMA's acceptability.

There is an absence of a validated instrument to measure the teacher's acceptance of using MMA (Hew, 2017; Papadakis et al., 2021). Currently, there are no instruments for measuring the instructional effectiveness of MMA. All of the existing instruments were developed for the MMA systems without rigorous validation processes (Alkhateeb & Al-Duwairi, 2019). All of the existing instruments were created by adopting the items from the literature review and without sufficient validation and translation methods (Alkhateeb & Al-Duwairi, 2019; Hew, 2017). The quality of the data collected will be as good as the instrument used to collect it. Weak data will result from a poorly constructed instrument, which will lead to bad conclusions. Therefore,

this study focuses on developing a rigorously validated instrument in the Malaysian context which can be easily used in the local context.

Statistical Data of research has created a positive interest related to the implementation of MMA. This positive interest has emerged because students realize that it takes an innovative breakthrough to improve the effectiveness of learning in a fast-changing curriculum as it is today (Yosiana et al., 2021). Learning by using MMA can increase students' interest in Mathematics learning and achievement. In Malaysia, nearly 55 MMA, online applications and software were identified to be readily available in use. However, these applications are not widely used as compared to other countries like Indonesia and Singapore (Barrientos, 2021).

According to Barrientos (2021), the use of the mobile application in teaching Mathematics has somehow helped enhance students' achievement and learning. He also suggests that the administrator should enforce and include the use of the mobile application in carrying out learning to its maximum. Besides him, Etcuban and Pantilope (2018) also state that teachers must be equipped with the latest trends for learners to become globally competitive. Therefore, it is important to identify the teachers' acceptance to use the available MMA. The lack of instruments is one of the reasons for the teachers' acceptance to use the MMA. Hence, this study initiates the development and validation of an instrument on teachers' acceptance to use the MMA.

According to Fabian, (2018); and Logical et al., (2023), using mobile technologies for Mathematics could be beneficial in some situations, further research is needed to help identify the teachers' acceptance, student achievements and which

learning environments are most suitable. This study could help the Ministry of Education (MOE) to identify the teacher's acceptance of using MMA in teaching and learning Mathematics. Besides that, the MOE also can consider giving training to the teachers on using MMA and help the schools invest in these technologies such as mobile devices, tablets and Ipads Fabian et al., (2018); Nafasov et al., (2023). It is even useful for the MOE to identify and conduct training for Mathematics teachers on the usage of MMA. It is important to consider the list of technical considerations that need to be addressed before implementing MMA in the classroom.

In this study, the RASCH Model is used as a construct validation tool. Several previous instrument developers had used the RASCH model in testing the construct validity (Apple, 2013; Matore, 2015; Khairani, 2017;). It has the ability to compute the raw data into an interval-level measurement that incorporates a method of ordering persons according to their abilities and ordering items according to their difficulties (Ramli, 2019). As a result, RASCH analysis enables an integrated strategy for a number of measurement concerns, all of which are necessary for the accuracy of the transition to interval scaling: Testing the invariance of items, which ensures that the difficulty ratio between any pair of items remains constant across respondents' ability levels for interval-level scaling, the internal construct validity of the scale for unidimensionality, the right category ordering (whether or not the category ordering of polytomous items is functioning as expected), and differential item functioning (DIF).

In Malaysia, according to the MOE, students are prohibited from bringing cell phones or smartphones to school (Ministry of Education, 2009). However, The Malaysian MOE has been urged to review the use of electronic devices in schools to

improve learning and teaching Syed, (2018); Nafasov et al., (2023). According to Jasni Md Kechik, president of the West Malaysia Teachers' Union, the review will allow the ministry to weigh the benefits and drawbacks of utilising devices in the classroom. "The employment of such gadgets is excellent in terms of teaching and learning," he stated Syed, (2018); Nafasov et al., (2023). Hence, with the help of a validated instrument, the MOE could allocate more budgets to equipping schools with more mobile phones and tablets and provide more training or courses for the Mathematics teachers to use MMA. In a nutshell, the product of this research; the instrument, will also aid the MOE to measure the teacher's acceptance of using MMA's in their teaching and learning in the classroom.

1.4 Research Objectives

Given the knowledge regarding the acceptance and use of MMA, this research has the following objectives:

1. To explore the Mathematics teachers' perspectives on using MMA.
2. To develop and validate an instrument for the factors that impact the Mathematics teacher's acceptance to use MMA.
3. To assess the Mathematics teachers' acceptance level of using MMA.

1.5 Research Questions

Based on the problem statements, this study has a few research questions to be put forward:

1. What are the Mathematics teacher's perspectives on using MMA?
2. Is an instrument developed and validated for the factors that impact the Mathematics teacher's acceptance to use the MMA?
3. What is the Mathematics teacher's acceptance level of using MMA?

1.6 Definition of Terms

1.6.1 M-learning

M-learning or mobile learning is learning across multiple contexts, through social and content interactions, using personal electronic devices (Sattarov & Khaitova, 2019). A form of distance education, m-learners use mobile device educational technology at their convenient time. M-learning technologies include handheld computers, MP3 players, notebooks, mobile phones and tablets. M-learning focuses on the mobility of the learner, interacting with portable technologies Al-Hunaiyyan et al., (2018); Jurayev, (2023). Using mobile tools for creating learning aids and materials becomes an important part of informal learning. In this study, M-learning is related to learning using Mathematics Mobile Applications in teaching and learning Mathematics. This learning

involves mobile phones, smartphones and tablets which act as learning tools in teaching Mathematics.

1.6.2 Mathematics Mobile Applications (MMA)

Mathematics Mobile Applications contain activities, practice problems and solutions Başaran & Haruna, (2017) and Jurayev, (2023). The application is well arranged in a way that it can be effectively used by learners to master the subject and better prepare for their understanding. Furthermore, mobile devices can be used in several ways to involve students in learning and education without being restricted by place or time, to enable students to continue learning activities within or outside classes through continuous interaction, communication, continuous support, and to provide follow-up (Al-Takhyneh, 2018; Papadakis et al., 2021). In this study, Mathematics Mobile Application is related to the usage of applications available online and offline for teaching and learning Mathematics.

1.6.3 Teachers' Acceptance

Teachers' acceptance of utilising technology in education is an essential part of modern teaching methods. Teachers who adopt technology recognise its potential to improve learning and teaching. They incorporate technology into their lesson plans to provide engaging and dynamic learning experiences for their pupils (Tseng et al., 2022). Teachers who are willing to use technology frequently seek opportunities for

professional development to learn how to integrate technology into their teaching practice properly. They attend workshops, webinars, and training sessions to improve their digital abilities (Nueva, 2019).

Teachers' acceptance of technology may differ depending on how comfortable they are with using digital tools. Some educators may quickly embrace technology and experiment with new tools, whilst others may be more hesitant and require further assistance and encouragement. Teachers are more willing to adopt technology when they see its advantages. This includes increased student involvement, personalised learning opportunities, access to a diverse range of materials, and greater administrative efficiency (Tseng et al., 2022). Teachers' embrace of technology may be hampered by a lack of access to devices and dependable internet connectivity, insufficient training and support, concerns about digital equity and access for all pupils, and opposition to change (Graham et al., 2020).

Creating collaborative learning communities within schools can help teachers embrace technology. When educators have the opportunity to share best practices, exchange ideas, and collaborate on technology integration techniques, they are more likely to adopt new digital tools and methods. School leaders play an important role in encouraging teachers to embrace technology. When leaders provide resources, motivation, and support for technology integration initiatives, teachers are more likely to feel encouraged to investigate and apply technology in the classroom (Kim & Lee, 2022).

Overall, teachers' perspectives towards technology in education are influenced by a variety of factors, including pedagogical principles, professional development opportunities, resource availability, and school leadership support. Teachers can increase acceptance by eliminating hurdles and cultivating a culture of innovation and collaboration.

1.6.4 Performance Expectancy (PE)

The degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al., 2003). From the context of the present study, Performance Expectancy has been defined as the extent to which Secondary school Mathematics teachers trust that using the VLE will help him or her achieve enhancements in job performance.

1.6.5 Effort Expectancy (EE)

The degree of ease associated with the use of the system (Venkatesh et al., 2003). From the context of the present study, Effort Expectancy is defined as the extent of ease associated with the use of MMA by the Secondary school Mathematics teacher.

1.6.6 Social Influence (SI)

The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003). From the context of the present study, Social Influence is defined as the extent to perceive the importance a Secondary school Mathematics teacher attaches to the opinions of others regarding his or her use of MMA.

1.6.7 Facilitating Conditions (FC)

The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system (Venkatesh et al., 2003). From the context of the present study, Facilitating Conditions as the extent to which Secondary school Mathematics teachers trust that school and technical infrastructure exist to support the use of MMA.

1.6.8 Self-Motivation (SM)

A desire to self-regulate by the teachers to engage with the system of their own choice (Ryan & Deci, 2000). It is also a feel to be effective in attaining valued outcomes when using the system. It will also make connected with and supported by individuals in their social surroundings to use the system (Ryan & Deci, 2000).

1.6.9 Students' Engagement (SE)

This engagement is characterized by students' regular interaction with the MMA, demonstrated through the frequency and duration of usage sessions, as well as the variety of features utilized within the MMA.

1.7 Limitation of Study

The core element of this research is about the teacher's acceptance of using MMA in teaching Mathematics. MOE is trying to upgrade and increase the usage of the MMA in the Malaysian education system. Although several MMA's are available in teaching and learning, this study focuses on the existing MMA. A lot of studies were carried out to find the real-world issues in utilizing MMA and work accordingly on its betterment (Al-Takhyneh, 2018; Alkhateeb & Al-Duwairi, 2019; Başaran & Haruna, 2017). So, this study will discover the real problems that hinder MMA from becoming a successful tool in teaching and learning. Hence, teachers are among the first individuals who will use the application before implementing it on the students. Due to that reason, this study is conducted on Mathematics teachers throughout the state of *Perak*.

To answer the research question and to achieve the research objectives, an instrument was developed and validated to identify the teacher's acceptance of using MMA in teaching and learning Mathematics. This study used an exploratory mix method approach by administering a survey questionnaire to the respondents to

measure the teacher's acceptance of using MMA. Therefore, this study is limited to instrument development, validation and measuring the use of the instrument.

Besides, this study is limited to Mathematics Mobile Applications only. It does not involve other subject applications or software. It only focuses on existing and freely available MMA and involves Mathematics teachers only. This is because the main task of Mathematics teachers is to deliver the teaching using different strategies and vary the teaching methods and tools using MMA.

Next, Malaysia has a diversity of geographical areas which causes some schools that cannot be contacted directly through the telephone or e-mail method, especially in the interior of Sabah and Sarawak. It also indirectly imposes financial implications on time and cost to carry out research. Thus, this study used teachers from Peninsular Malaysia especially *Perak* as a population of studies. It also focused on secondary school teachers only as there are more MMA and software readily available for the secondary school syllabus (Alkhateeb & Al-Duwairi, 2019).

1.8 Significance of Study

This research is significant for the following stakeholders:

1.8.1 The Ministry of Education (MOE)

MMA is still a new teaching and learning platform for teachers and students. This research studied the teacher's acceptance of using MMA in teaching Mathematics. Therefore, the findings of this study especially the instrument can help the ministry to improve all the difficulties faced by the Mathematics teachers to integrate the technology with their lessons. Besides that, the findings could reveal the necessities and needs of teachers, especially Mathematics teachers to incorporate MMA in teaching. MOE also may use the findings as a guideline to adopt a new MMA platform or develop their own MMA platform to increase the use of MMA in teaching and learning Mathematics by teachers. MOE can provide more training on MMA to all level teachers and educators to familiarise MMA in the teaching and learning system.

1.8.2 Application Developers

The developers of the Mathematics application may use the data of this study to construct and develop a new version of MMA which is adored by teachers. They can always upgrade and maintain their applications besides adding more meaningful and attractive functions. From this research, the application developers can determine the teachers' perceptions of their applications. The developers can improve their application if there is any limitation. The MOE should hire more developers to create more MMA and integrate it into the education system.

1.8.3 Teachers

This research increases the teacher's awareness of using MMA as well as builds their confidence to use the existing MMA. An instrument was developed based on the results from the interviews conducted among the teachers and the literature review. The instrument was based on results from the teachers, as the usage of MMA will help teachers save their time and energy. This study showed the steps and plans imposed by MOE on the upgraded Malaysian education system, especially for Mathematics education. Teachers are a part of the Malaysian education system, whereby they are the determiner of MMA's success. Thus, this study can help the teachers to understand their vital role in upgrading the Mathematics education system.

1.8.4 Students

In Malaysia, usually, the teachers are the individuals who will determine the method of teaching and learning in class. Hence, when a teacher decides to use MMA in their teaching and learning session, students are more interested in the lesson, especially in Mathematics. Indirectly, this helps the students to be more focused in class and achieve the lesson's objectives. Besides, it also helps in their achievement in Mathematics. It helps their cognitive growth which is based on knowledge and information.

1.9 Chapter Summary

This chapter integrated the importance and needs of this study. The rationale of this study was clearly stated in the research objectives where this study needs to be carried out to find out the real paradigm of MMA as a teaching tool. Furthermore, the study is about a developed and validated instrument as mentioned in the problem statement and background of the study. The research questions enlightened the various parties related to MMA implementations. Research scope and limitations are also stated to highlight the boundaries of this research. Last but not least the research gap was discussed in this chapter to seek the real problems behind the usage of MMA in teaching and learning Mathematics. In conclusion, in this chapter, the researcher has presented an overview of the proposed instrument. It involved the discussion about the introduction, background of the study, problem statement, research objectives, research questions, the definition of terms, limitations of the study and the significance of the study. The next chapter will describe the literature review which provides further explanation of this study.