Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 3, 5013 – 5023

Mobile Application In Mathematics Education: A Study Among Malaysian Secondary School Mathematics Teachers

[1]Murugan A/L Rajoo*,[2]Lay Yoon Fah,[3]S. Kanageswari A/P Suppiah Shanmugam, [4]Siti Noor Ismail, [5]Nelson Cyrill, [5]Mariam Othman, [6]Shazlyn Milleana Shaharudin

*[1,6] Faculty of Sciences and Mathematics, University Pendidikan Sultan Idris, [2] University Malaysia Sabah, [3,4] School of Education and Modern Languages, University Utara Malaysia, [5,6] SEAMEO RECSAM, *Corresponding author: murugan@fsmt.upsi.edu.my*

Abstract

Mathematics Mobile Application delivers learning to students using smart devices, such as smartphones, personal digital assistants (P.D.A.s), and tablet PCs using wireless internet. This research aimed to (a) develop an instrument of Mathematics Mobile Application and (b) identify the level of using MMA by Malaysian secondary school mathematics teachers. This study employed a quantitative research design. 280 teachers were sampled from the Malaysian regular secondary schools. One set of Mathematics Mobile Application (MMA) questionnaires was developed from the literature review and validated by experts. The survey data were analyzed using the Rasch analysis. Research findings revealed that the MMA instrument was examined the psychometric properties, whereby all the items developed based on the review were within the infit and outfit MNSQ of MMA (1.68 to 1.87) logits. In terms of unidimensionality, the first construct's eigenvalue is 3.6, which illustrates the existence of other dimensions. This means that the MMA is multidimensional, supporting the four dimensions from the literature review. The Wright map illustrates that most of the items were at the medium and easier difficulty level. There are no items too easy or high-level difficulty to endorse agreeability. The mean practice level of MMA by secondary school mathematics teachers was 2.978 (SD = 0.369), indicating a moderate level of secondary school mathematics teachers' usage of MMA. This study aims to add to the reviewed literature and instruments to mathematics education.

Keywords: Mathematics Mobile Application, Questionnaire, Rasch Analysis

1.0 INTRODUCTION

Developed countries are not left behind by technology. Education in developed countries is based on technology. About this matter, numerous technologies have been innovated by experts for educators to make daily lessons fascinating. Mobile phones have new features to suit education, especially in mathematics. The available software and online applications for mathematics classrooms are GeoGebra, MathRush, MobileMath, Studierstube, Angle Tool, Video, Algosketch, Multiplication Genius, Mad Math, Pop Math, Flash to Pass, Math Drills, Math Magic, Flowmath, and Multiplication Flashcards to Go, Sara Skates, Birthday Café, Jungle Gym, BubbleFun, Breakfast Time, Lemonade Stand, Photo Friends and ParkPlay, AGILMAT, Web-based Mathematics Education (WME) system, and 4MALITY. According to Handal, El-Khoury, Campbell, and Cavanagh (2013), all these applications were categorized into nine; (1) emulation, (2) simulation, (3) guided discovery, (4) measurement, (5) drawing/graphing, (6) composing, (7) informative, (8) drill and practice, and (9) tutorial apps. According to Drigas and Pappas (2015), smartphone learning apps inspire students and render math classes more enjoyable and engaging than traditional teaching methods. Nevertheless, at the national level, the use of technology in the mathematics classroom is still something unanswered by researchers.

Besides, mobile applications in the classroom require further study as many applications can be found in the search engine, which helps in the mathematics classroom. Some ASEAN countries allow students to bring their gadgets to the classroom to learn. Research has proved that 92 % of the learners favored learning after using mobile applications (Hamat, Embi & Hassan, 2012). On the other hand, Respondents claimed that individuals tend to learn through smartphone apps. This was because the smartphone apps helped them grasp the concept and audio (the sound of native speakers) and visuals. It was also reported that the users felt satisfied with high applications (Chachil, Rias, Engkamat, & Sarkawi, 2015). Math success increased when learners used their phones in the classroom (Kachepa & Jere, 2014). Mobile learning refers to delivering information to students through cordless Internet and mobile devices such as smartphones, personal digital assistants (PDAs), laptops, and ipads. This study focuses on north region Malaysians' secondary school mathematics teachers' perception of using mobile phones in the mathematics classroom.

1.1 Research objectives

(a) To develop an instrument on teachers' perception of using mobile applications in the secondary mathematics classroom
(b) To identify the level of using MMA by Malaysian secondary school mathematics teachers

2.0 Mobile Applications for Teaching and Learning of Mathematics

Mathematics subject consists of four major branches: number, algebra, geometry, and statistics. Mobile applications in these four branches play an essential role in promoting mathematics lessons among students worldwide. The mobile applications help the teachers to identify the topic and relevant applications on a specific topic to make the lesson more meaningful. Recently, many online learning applications and tools for mathematics have been developed and presented. These learning apps may be accessed at any time and from any location using wireless connectivity. Researchers worldwide conducted much research on the usage and mobile applications in education, especially mathematics. The review of mobile applications revealed that learning can happen anytime and anywhere. Botzer et al. (2007) sampled four female learners using phone applications revealed that mobile phone applications encourage students' engagement in learning mathematics and promote better mathematics' achievement among students. In another study, scholars studied mathematics software in the tablet for primary school students. This study was participated by 60 students of 4th grade from Pennsylvania. This software allowed the teachers to monitor their students' performance and engagement with the given task. This study's findings showed that mathematics teachers faced problems when integrating their curriculum into applying the mathematics software system. However, the teachers mentioned that the software promotes teaching skills (Petty et al., 2007). PDAs (Personal Digital Assistants) also play a crucial role in promoting mathematics learning among students. Wachira et al. (2009) conducted a study integrating inquiry-based mathematics in PDA involving ratio, data analysis, measurement, and geometry. This study was participated by 20 mathematics trainee teachers from Midwestern University.

At the end of the slot, the participants were given opportunities to state their PDA usage in teaching and learning mathematics. The findings informed that most participants commented that the PDA was an exciting and valuable technology aid for mathematics lessons. Besides, they wanted to explore the PDA further to create more compelling experiences for their students. Wang et al. (2003) developed an Open Mathematics Education (OME) program based on the Internet, using standard Internet technologies. This system allows users to create unlimited mathematics lessons and materials. The system is also connected to Mathematical Education Markup Language (MeML) and delivered pages. Besides, mathematics teachers benefit from the system by enhancing mathematics lessons using technology.

In 2007, Tomas, Leal, and Domingues innovated another web application called AGILMAT AGILMAT, mainly designed to help high schools with topic algebra. This application auto-generates questions based on students' capabilities and preferences. Besides, teachers can alter the problems by changing their values. This innovation favor mathematics teachers to assign algebra tasks to students based on students' level and capabilities.4MALITY, known as a web-based mathematics tutoring system, was inverted by Edwards et al. (2010). 4MALITY adapts to the students' levels of knowledge by using an

Artificial Intelligence decision system. The system comprises four categories of learning styles: Explain questions in terms of the language used, Mathematical computational operation, Test-taking and problem-solving strategies, and Visual approaches to computation. Mathematics teachers are enjoying the benefit of 4MALITY in planning their lessons.

3.0 METHODOLOGY

The study design is described first in this chapter. The sampling process, data gathering techniques, and data analysis are all described in quantitative methods. The steps of research instruments development and how they corresponded to the qualitative and quantitative techniques are also covered.

3.1 Sampling

The instrument was administered to the selected sample. A simple random sampling technique was used in this research. The population for this study was all the secondary school mathematics teachers from Penang and Kedah state. The total number of samples will be determined using Krejcie and Morgan table. A total of 280 mathematics teachers from Penang and Kedah states were involved in the real study.

3.1 Instrumentation of Mathematics Mobile Applications (MMA) Questionnaire

The survey questionnaire is superior to other methods regarding the efficiency of the original data collected from the sample population. Questionnaires are mostly used in the data collection method in quantitative aspects (Radhakrishna, 2007). A survey was used to obtain information from the sample for the quantitative aspect of the study. In this study, the researcher designed one research instrument (Mathematics Mobile Application, MMA) for the quantitative method. The research instrument in this study consisted of five constructs: efficacy, accessibility, support, active learning, and mathematics achievement. All the items were developed based on the literature review on MMA. The questionnaire used in a study needs to be valid and reliable. To have a valid and reliable questionnaire, the systematic development of the questionnaire is a must to reduce measurement errors (Radhakrishna, 2007). Several steps need to be considered in developing a valid and reliable questionnaire.

The goal, aim, research questions, and hypothesis were defined first. The samples chosen were Sabah regular secondary school students. The following move is to create statements for the survey. This stage works by converting information (from the literature/theoretical framework) into statements/questions. The researcher used the contents of the literature review to generate items. (Radhakrishna, 2007; Hill & Koekemoer, 2013). Next is to write the statements, select suitable statistics, questionnaire structure, style, order of questions, font size, font, and back covers, and the proposed data analysis are all addressed. Scales are instruments used to measure a person's reaction to a certain variable. (Radhakrishna, 2007). The new items were suggested to be scaled using five or seven-point Likert scales (Radhakrishna, 2007). Measures with five- or seven-point scales have been shown to create a variance necessary for examining the relationships among items and creating adequate coefficient alpha (internal consistency) reliability estimates (Lissitz & Green, 1975).

From step one to three, a draft questionnaire is ready for establishing validity. Validity is the ability of an instrument to measure what is supposed to be measured for a construct (Creswell, 2012). Validity is established using a panel of experts and a field test. The questionnaire is now ready for a pilot test after collecting feedback and advice from an expert. The questionnaire's reliability is tested as a pilot test in this final phase. Random error in calculation is referred to as reliability. The ability of a sample to generate consistent results over time is referred to as reliability (Colton & Covert, 2007). The MMA survey contained demographic traits of teachers. Teachers were questioned about the level of facility availability.

3.2 Content and Face Validity

In this study, the items about MMA were developed from the literature review. Two experts then reviewed the items. Two university lecturers from Sultan Idris Educational University (UPSI) were the experts. The experts were asked to write comments, suggestions, recommendations, and questions on the items. This procedure aimed to learn more about item concepts, vocabulary, and the appropriateness of regular and non-regular items. After completing the procedure, the items were sorted into various constructs. (Efficacy, accessibility, support, active learning, and mathematics achievement). After receiving all the feedback from the experts, the comments and suggestions were analyzed. In addition, the mathematics education specialist said that certain aspects of the instrument needed to be improved. The corrected version was submitted to five teachers for face validity testing. All of them was given a copy of the questionnaire to get their feedback on the suitability of the items in terms of their wording, the procedures, and whether the scales are comprehensible to identify any obstacles they may have encountered when filling out the survey

3.3 Pilot Study

The sample size for the pilot study was set according to literature norms, which indicated that perhaps the sample size for the pilot survey is maintained low, i.e., up to 100 respondents (Colton & Covert, 2007). The instrument's pilot test randomly distributed 50 surveys to high school mathematics instructors in northern states such as Penang and Kedah states. In the purification step of the instrument, the next level after content validity is the instrument's reliability, which guarantees that steps are unbiased and thus produce accurate data (Peterson, 1994). To determine the total measurement error in the test, the current study used Cronbach's alpha coefficient method. In general, Cronbach's coefficient has a lower acceptable limit of 0.72. However, at 0.60, it is considered appropriate. Sekaran (Sekaran, 2003). Tables 3.1 and 3.2 show that both conceptions of this study (pilot test) are stable. (Alpha Cronbach's alpha is more than 0.7).

Table 3.1

Reliability of Mathematics Homework Engagement constructs in the pilot test

Mathematics Homework Engagement	**Number of items**	**Coefficient Alpha**
Efficacy (1)	9	0.924
Accessibility (2)	8	0.913
Support (3)	6	0.911
Active Learning (4)	7	0.908
Mathematics Achievement (5)	6	0.901

In addition, exploratory factor analysis (EFA) was run to confirm that the data support the selected scale for the present study. The overall reliability of the instrument within piloting was $\alpha = 0.883$ or 88.3%, which is above the recommended threshold of 0.7 (Nunnally, 1978).

Table 3.2

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.901**
Bartlett's Test of Sphericity	Approx. Chi-Square	1952.256
	df	201
	Sig.	0.000

Table 3.2 indicates that EFA results revealed the Kaiser-Mayer-Olkin (KMO) statistics of which the measurement of sampling adequacy was higher than the minimum recommended value of 0.60 (Kaiser, 1974) for all of the constructs. In addition, the significance of Bartlett's test of Sphericity indicates that the correlation among the measurement items was higher than 0.3 and was suitable for EFA (Hair et al., 2006). Table 3.3 shows that the total variance extracted by the questions within the constructs was 86.46 %. As a result, there is no issue with construct validity.

Table 3.3

Total variance Explained for Mathematics Mobile Applications factors

Componen	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	9.23	41.07	41.07	9.23	41.07	41.07	4.82	25.44	25.44
2	3.67	20.03	61.10	3.67	20.03	61.10	4.12	22.55	47.99
3	3.06	15.35	76.45	3.06	15.35	76.45	4.10	19.45	67.44
4	2.76	10.01	86.46	2.76	10.01	86.46	3.85	19.02	86.46

Extraction Method: Principal Component Analysis.

The rotated component matrix is shown in Table 3.4. The results demonstrate four elements, each of which has a loading factor greater than 0.5. As a result, the convergent validity of the pilot test's constructions is unaffected.

Table 3.4

Rotated Component Matrix

Items	Mathematics Mobile Applications			
	EF.	**AC**	**SP**	**AL**
EF2	.943			
EF4	.931			
EF5	.908			
EF1	.889			
EF8	.834			
EF3	.791			
EF9	.768			
EF7	.755			
EF6	.707			
AC3		.911		
AC5		.903		
AC6		.893		
AC2		.878		
AC8		.832		
AC1		.796		
AC4		.765		
AC7		.732		
SP3			.922	
SP5			.910	
SP6			.857	
SP4			.809	
SP2			.795	
SP1			.725	
AL2				.867
AL6				.853

Items	Mathematics Mobile Applications			
	EF.	AC	SP	AL
AL4				.790
AL7				.741
AL1				.724
AL3				.764
AL5				.701

Overall, the pilot study revealed that the alpha reliability coefficients for all the items are acceptable. Therefore, all these items remained for the main study. Thus, the questionnaire could be distributed to the targeted sample.

4.0 RESULTS

Demographic characteristics of the respondents

Table 4.1 illustrates the demographic information of the samples that participated in the study based on gender, age, ethnic groups, and states. Overall, there are 280 questionnaires completed by the respondents in northern Malaysia.

Table 4.1
Demographic information of the samples (N=280)

Variables		Frequency	Percent (%)
Gender	Male	105	37.4
	Female	175	62.6
Age	below 25	15	5.4
	25-29	38	13.6
	30-39	54	19.2
	40-49	140	50.0
	50-59	33	11.8
Ethnic groups	Malay	103	36.8
	Chinese	76	27.0
	Indian	91	32.5
	Others	10	3.7
State	Penang	164	58.6
	Kedah	116	41.4

Most of the samples in this study are aged between 40 to 49 years old, which represents 50.0%, followed by 30 to 39 with 19.2% and 25-29 with 13.6%. Table 4.1 shows 105 (36.4%) of the samples are male, and 175 (62.6%) are female. Based on ethnic groups, the majority of the samples are Malays (36.8%), followed by Indians (32.5%) and Chinese (27%). In terms of states, most of the samples were from Penang and followed by Kedah state.

4.1 Model data fit and item polarity

The findings of this study showed that the infit and outfit MNSQ fall within the acceptable range, which is from 0.5 to 2.0 (Fisher, 2007). The value of infit and outfit MNSQ of MMA is 1.68 to 1.87 logits. This means that, according to Fisher (2007), a range from 0.5 to 2.0 is considered good. The standard error for all the 36 items in this study is within the range of .06 to .07. The value of standard error is considered important to indicate the accuracy in measurement (Linacre, 2011). The standard error value is still below the value of 0.25, which can be categorized as excellent (Fisher, 2007).

4.2 Unidimensionality of MMA.

Findings from the procedure of Principal component analysis of residual that shows in Table 4.3 indicate raw variance explained by measure, which is 33.2% and found to be closer with the modeled (33.6%). This finding fulfills the criteria of unidimensionality for Rasch, whereby the minimum percentage is 20% for both PCA and the estimated model (Conrad et al., 2012). The unexplained variance in the first contrast revealed a value of 6.6% and was categorized as very good and sufficient (Eakman, 2012; Fisher, 2007; Linacre, 2007). The eigenvalue of 1st contrast is 3.6 illustrates the existence of the second dimension (Linacre, 2007). This means that the MMA is multidimensional, supporting the four dimensions that emerge from the literature review. Therefore, there is a need to run the unidimensionality for each construct of MMA.

4.3 Wright map with individual

Based on the wright map of the individual ability and item difficulty in one straight line, E1 (I know how to use the MMA) and E2 (I am familiar with MMA) are the most difficult items to agree with by the respondents. However, the easiest items to agree on are MA1 *(My students' marks improved in mathematics after using MMA)* and S3 *(MMA helps me solve mathematics questions when I have problems to solve).*

The highest ability of the respondents to answer is +2.91 logits, and the lowest value is -1.22 logits. However, the highest item difficulty is +.51 logits, and the lowest item difficulty is - .39 logits. The range of personability is +4.13 logits, and the range of item difficulty is +.90 logits. The mean of item difficulty is lower compared to the mean of personability. This revealed that MMA items are easy for the respondents to endorse agree. The value for item difficulty distribution is placed between +.51 logits to -.39 logits fulfills and passed the range between+3.00 logits to -3.00 logits, which were classified as poor (Andrich & Styles, 2004; Hill & Koekemoer, 2013). In this study, the difference between the mean of individual ability is higher than the mean of item difficulty. This means that many respondents agreed with the Likert four (agree) and five (strongly agree). This explains that MMA items in this study are easy to endorse agreeability, and as an outcome, the respondents' achievement in answering the items is higher.

The lacking of items for individuals with lower and higher abilities needs to be measured from .51 logits to +2.91 logits. The ability of items to distribute the individuals can be done by aligning the distribution of items that starts with the mean of item difficulty, which is starting from 0.00 logit. The next border should be placed at the mean of individual ability (+0.27) logits. The line placement above the items is +.51 logits, and the line placement below the items is -0.39 logits. The map shows no gaps between the items. This means that the items accurately measure the respondents with a medium ability level. However, further research is a need to develop more items that are difficult for measuring respondents with high ability. This instrument also revealed the lack of items measuring the respondents with higher ability. The addition of items from .51 logits to 2.91 logits is expected to help to measure the respondents with higher ability. The MMA items only measured the respondents with medium and low ability. The wright map indicates that there are no very easy or very difficult items.

4.4 Reliability and Separation

The overall value of person reliability is 0.93, between .91-.94 categorized as excellent (Fisher, 2007). The findings show that MMA items' distribution and personability are adequate to get a good reliability score. The overall value of item reliability is 0.91, and the value of Cronbach Alpha is 0.94. This indicates that the item reliability is very good, between the ranges of 0.91 - 0.94. Additionally, according to Sekaran and Bougie (2011), Cronbach Alpha's value above 0.80 is considered good.

The overall person separation index is 2.90, and the item separation index is 1.55. This represents that the person ability is distributed along the logit, unlike the item difficulty whereby the item reliability is lower than person reliability. Fisher (2007) stated that the separation index should be more than 2.0. The person separation index passed this criterion for the overall and accessibility construct. However, the item separation index does not fit this criterion except for the efficacy construct (2.75) and mathematics achievement (2.68). However, according to Duncan, Bode, Lai, and Perera (2003), the value of item separation above 1.50 is categorized as acceptable. Among all the constructs, Efficacy and

Mathematics achievement have the same high value of Person reliability index (0.75). There is no similar index for item separation in terms of Item Separation and Item Reliability. The similarity index is found for item reliability, whereby accessibility and support constructs indicate 0.78, and efficacy and mathematics achievement constructs are reported to be 0.88.

4.5 The level of using MMA by Malaysian Secondary School Mathematics Teachers

Results showed that only 0.4% of the teachers had a low level of MMA usage. The finding revealed that 61.3% of the secondary school mathematics teachers used MMA at a moderate level, while 38.2% perceived MMA highly. Overall, the mean was 2.978 (SD = 0.369), indicating a moderate level of secondary school mathematics teachers' usage of MMA.

5.0 Discussion of research findings

The items of MMA fulfilled three main criteria of the Rasch model: model fit unidimensionality and Wright map. The findings of this study showed that the infit and outfit MNSQ fall within the acceptable range, which is from 0.5 to 2.0 (Fisher, 2007). The value of infit and outfit MNSQ of MMA is 1.68 to 1.87 logits. This finding fulfilled the criteria of unidimensionality for Rasch, whereby the minimum percentage is 20% for both PCA and the estimated model (Conrad et al., 2012). This finding fulfills the criteria of unidimensionality for Rasch, whereby the minimum percentage is 20% for both PCA and the estimated model (Conrad et al., 2012). The unexplained variance in the first contrast revealed a value of 6.6% and was categorized as very good and sufficient (Eakman, 2012; Fisher, 2007; Linacre, 2007). The eigenvalue of 1st construct is 3.6 illustrates the existence of the second dimension (Linacre, 2007). This means that the MMA is multidimensional, supporting the four dimensions that emerge from the literature review. The unidimensionality of each MMA construct was examined, which fit the Rasch model.

Furthermore, the MMA instrument was strengthened using two more criteria: item polarity. All the MMA items are within the range of 0.5 to 2.0 is considered good (Bond & Fox, 2007) for a good survey instrument. In terms of internal consistency, the value of Cronbach Alpha for the overall MMA instrument is 0.94, which is above 0.80. Within the Rasch model, the item reliability and person reliability for the overall MMA survey items are 0.91 and 0.93, respectively. The overall Person reliability for MMA is above 0.80, as proposed by (Sekaran & Bougie, 2011). The overall item reliability is observed to be below 0.80. However, a value above 0.70 is still acceptable (Hair et al., 2013). It is examined that most individuals could endorse agreeability more with the MMA items even though the respondents vary in terms of age and gender. In terms of separation, the MMA items indicate that the person separation index is reported to be closer to 2.0, which are efficacy (1.76), accessibility (2.06), Support (1.65), and Active Learning (1.95). In terms of the dependent variable, the Mathematics Achievement constructed was reported to be a 1.71-person separation index. According to Duncan et al. (2003), the person separation index above 1.50 is still acceptable. This finding is also in line with Green's (2002) provision, which states that the separation must exceed one or more to represent the distribution of items and the ability of the respondents to endorse agree as it scaffolds to make a practical MMA instrument. Overall, MMA still has a good separation index of more than two as a whole, which proves that the MMA items can separate based on the difficulties of the items and teachers' abilities for the measured MMA construct.

Regarding the level of MMA practice by secondary school mathematics teachers, results showed that there was only 0.4% of the teachers with a low level of MMA usage. The finding revealed that 61.3% of the secondary school mathematics teachers used MMA at a moderate level, while 38.2% perceived MMA highly. Overall, the mean was 2.978 (SD = 0.369), indicating a moderate level of secondary school mathematics teachers' usage of MMA. These findings illustrate a big difference between the low (0.4) and moderate (61.3). This indicates that most teachers favor using MMA in their lessons. The literature revealed that low-skilled students were more interested and beneficial from mobile learning compared to ordinarily skilled students (Ketamo et al., 2002). Besides, the engagement of students in mathematical topics increases. The role of mathematics teachers is significant to fit their students based on their capabilities in learning mathematics (Ketamo et al., 2002).

Implication of the study

This study's findings contributed to the empirical studies on MMA in Malaysia. The study validates the four aspects of the literature review, indicating that the MMA is multidimensional. As a result, the purpose of this research is to add to the reviewed literature and contribute to Mathematics Educational studies worldwide, particularly in developing countries such as Malaysia. It has been recommended that MMA extend beyond student achievement, and this study aimed to fill this gap by researching the Mathematics Mobile Application from the literature. These contributions are likely to boost the Mathematics Mobile Application. The quantitative research approach was used to investigate the psychometric features of the MMA instrument in conjunction with the local context. There are four key prevailing stakeholders in the school setting: practitioners, policymakers in government, the school system itself, and instructors.

As a result, the practical implications will be aimed at these parties. As a result, various practical implications are presented. First, from the standpoint of MMA, this study supports the notion that MMA's approach to mathematics education is highly contextualized. Hence, the practice of MMA at a school at any point in time must be linked to Mathematics Achievement. As different stages of the mathematics performance initiatives unfold, school systems must be required to adapt their strategies to the ever-changing circumstances.

Additionally, this study presents a broad perspective on how MMA can improve Mathematics instruction and accomplishment. This study emphasizes the importance of the MMA as a catalyst for mathematics achievement, implying to policymakers that one person cannot improve the curriculum, syllabus, or the mathematics subject itself and that MMA practices should be encouraged in the school system to expand opportunities for direct impact on achievement. In terms of policy and practice, a clear description of the nature of MMA on mathematics education is essential to guide practitioners toward aims and approaches that will have the greatest influence on student accomplishment. According to the outcomes of this study utilizing the resource base perspective, every mathematics teacher at a school should assess by looking at the MMA they use the most. Contributions to the methodology were also identified. The literature review was used to discover and develop the variables in this study. To generate one set of validated MMA instruments, the psychometric properties of the measures were carefully investigated using the Rasch analysis, which was explained in the methodology. The final MMA instrument provides valid and trustworthy data on the factors studied in this study to researchers in Malaysia and worldwide.

6.0 CONCLUSION

From the result of the present study, the review of MMA has gone a step further in showing the universality of these MMA in the Northern Malaysian context. This study also developed a validated MMA instrument that was responded to by the Malaysian national regular secondary school teachers. The followings are the results from this study:

(1) In terms of psychometric properties of the MMA instrument, all the items developed based on the review, which was within the infit and outfit MNSQ of MMA (1.68 to 1.87) logits.

(2) In terms of unidimensionality, the eigenvalue of the 1st construct is 3.6, which illustrates that there is an existence of the second dimension (Linacre, 2007). This means that the MMA is multidimensional, whereby it supports the four dimensions that emerge from the literature review.

(3) The Wright map illustrates that most items are at the medium level and easier level difficulty. There are no items that are too easy or high-level difficulty to endorse agreeability.

(4) Regarding the level of MMA practice by secondary school mathematics teachers, the mean of MMA was 2.978 (SD = 0.369), indicating a moderate level of secondary school mathematics teachers' usage of MMA.

REFERENCES

Andrich, D. (1978). A rating scale formulation for ordered response categories. Psychometrika, *43*(2), 561-573.

Andrich, D., & Styles, I. (2004). Final Report on the psychometric analysis of the early development instrument (EDI) using the Rasch Model: A technical paper commissioned to develop the Australian Early Development Instrument (AEDI). Perth, Australia. Retrieved from http://ww2rch.org.au/emplibrary/australianedi/Final_Rasch_report.pdf.

Ary, D., Jacobs, L., and Razavieh, A. (2002). Introduction to Research. 6th Edition, Wadsworth, Belmont.

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences* (2nd ed.). Lawrence Erlbaum Associates Publishers.

Botzer, G., & Yerushalmy.M. (2007). Mobile application for mobile learning. In Proceedings of the International Conference on Cognition and Exploratory Learning in Digital Age, 7-9.

Chachil, Ketty & Engkamat, Adeline & Sarkawi, Adib & Shuib, Awang. (2015). Interactive multimedia-based Mobile Application for Learning Iban Language (I-MMAPS for learning Iban Language). Procedia - Social and Behavioral Sciences. 167, 267-273.

Colton, D. & Covert, R.W. (2007) Designing and constructing instruments for social research and evaluation. John Wiley & Sons.

Conrad, K.M., Conrad, K.J., Dennis, M. L.., &Funk, R. (2012). Validation of the self helps Improvement Scale to the Rasch measurement model GAIN methods repost 1.0 Chicago. Taylor & Francis.

Creswell, J. W. (2012). Qualitative inquiry and research design: Choosing among five approaches. London: SAGE Publications, Incorporated.

Diamantopoulos, A., & Siguaw, J. A. (2000). Introducing Lisrel: A Guide for the Uninitiated. Sage.

Drigas, Athanasios & Pappas, Marios. (2015). A Review of Mobile Learning Applications for Mathematics. International Journal of Interactive Mobile Technologies, 9, 18-23.

Duncan, P. W., Bode, R. K., Lai, S. M., & Perera, S. (2003). Rasch analysis of a new stroke-specific outcome scale: The stroke impact scale. Archives of Physical Medicine and Rehabilitation, *84*(7), 950-963.

Eakman, A.M. (2012). Measurement characteristics of the engagement in meaningful activities survey in an age-diverse sample. The American Journal of Occupational Therapy, *66*(2), 20-29.

Edwards, R. W., Maloy S. A., & Gordon, A. (2010). Teaching math problem solving using a web-based tutoring system, learning games, and students' writing. Journal of STEM Education, *11*(1-2), 82-90.

Fisher, W. P. (2007). Rating Scale Instrument Quality Criteria. Rasch Measurement Transactions, *21* (1), 1095.

Hair, Jr., J.F., Black, W.C., Babin, B.J., Anderson, R.E., Tatham, R.L., 2006. Multivariate data analysis (6th Ed.), Pearson-Prentice Hall, Upper Saddle River, NJ.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2013). Partial least squares structural equation modeling: Rigorous applications, better results, and higher acceptance. Long Range Planning, *46*(1–2),1–12.

Hamat, A., Embi, M. & Abu Hassan, H. (2012) 'The use of social networking sites among Malaysian university students,' International Education Studies, *5*(3).

Handal, B., El-Khoury, J., Campbell, C., & Cavanagh, M. (2013). A framework for categorising mobile applications in mathematics education. Australian Conference on Science and Mathematics Education.

Hill, C., & Koekemoer, E. (2013). The development of the MACE work-family enrichment instrument. SA Journal of Industrial Psychology, *39*(2), 116-117.

Kachepa, A & Jere, N. (2014). Int. J. Sci. Knowl. Comput. Inf. Technol. 55(6). Kaiser, H.F. (1974). An index of factorial simplicity. Psychometrika, 39, 31-36.

Ketamo, H. (2002). Mobile Learning for kindergarten's mathematics teaching. Wireless and Mobile Technologies in Education, 2002. Proceedings. IEEE International Workshop.

Linacre, J. M. (2011). Winsteps (version 3.70.0) [Computer software]. Chicago:Winsteps.com.

Linacre, J. M (2007). A user's Guide to WINSTEPS: Ministep Rasch Model Computer Programs. Chicago: MESA Press.

Lissitz, R. W., & Green, S. B. (1975). Effect of the number of scale points on reliability: A Monte Carlo approach. Journal of Applied Psychology, *60*(1), 10– 13.

Nunnally, J. O. (1978). Psychometric Theory. New York: McGraw-Hill.

Peterson, R. A. (1994). A Meta-Analysis of Cronbach's Coefficient Alpha. Journal of Consumer Research, 381-391.

Petty, D. D. (2007). Integration and Perception of Tablet PC Mathematics Software in Elementary Mathematics Education.Dietrich College of Humanities and Social Sciences at Research Showcase.

Radhakrishna, R. B. (2007). Tips for Developing and Testing Questionnaires Instruments. Journal of Extension, *45*(2), 24-54. Retrieved from http://www.joe.org/joe/2007february/tt2.php.

mputation, ACM.

Sekaran, U. (2003). Research methods for business: A skill-building approach. New York: John Wiley & Sons. Inc.

Sekaran, U., & Bougie, R. (2011). Research Methods for Business: a skill-building approach (5th ed.). New Delhi: John Wiley & Sons.

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L. P., Robson, R., Thabane, M., Giangregorio, L., & Goldsmith, C. H. (2010). A Tutorial on Pilot Studies: The What, Why and How. BMC medical research methodology, *10*(1),1.

Tomás, A. P., Leal, J. P., & Domingues, M. A. (2008). A web application for mathematics education. In Advances in Web-Based Learning– ICWL 2007, SpringerBerlin Heidelberg.

Wachira, P., Keengwe, J., & Onchwari, G. (2009). Personal Digital Assistants (P.D.A.s) in mathematics Teacher Education. AACE Journal, *17*(2).

Wang, P. S., Kajler, N., Zhou, Y., & Zou, X. (2003). WME: towards a web for mathematics education. In Proceedings of the 2003 international symposium on Symbolic and algebraic co