NEED ANALYSIS FOR THE DEVELOPMENT OF A MOBILE-LEARNING MODULE FOR LOWER SECONDARY SCHOOL ALGEBRA

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ABSTRACT: *Mathematical knowledge is the pillar of integrated Science, Technology, Engineering, and Mathematics (STEM) education which ensures the future generation is well-equipped with the knowledge and skills required to compete globally. However, recent studies show that students have yet to achieve the mastery level expected in one of the crucial learning areas of mathematics: algebra. This paper aims to determine teachers' perceptions of the level of difficulties students face, the hindering factors, and the possibilities of implementing a mobile-learning approach in learning algebra topics for Form Two Mathematics. This study used an online questionnaire involving 178 lower secondary mathematics teachers in Kuala Lumpur. The data collected were analyzed using descriptive statistics, namely percentage. The findings revealed that Factorisation and Algebraic Fractions is the most challenging topic for students to master in Form Two Mathematics, according to 91.0% of teachers. Moreover, 94.4% of teachers agreed that students faced difficulties representing mathematical statements and problem-solving involving algebraic terms. This study also found that 94.4% of teachers agreed that mobile learning would enable students to explore learning through an interactive approach and provide the opportunity for blended learning. The findings also revealed the suggested features such as learning skills, learning activity, learning materials, and evaluation methods for the mobile-learning module. This study indicates a need to develop a mobile-learning module for Factorisation and Algebraic Fraction to enhance students' achievement and learning experience.*

Keywords: Lower secondary school algebra, mobile-learning, m-learning, need analysis, module development

1. INTRODUCTION

The emergence of the fourth Industrial Revolution (IR4.0) has changed the landscape of education throughout the world [1]. As a result, educators worldwide emphasize Science, Technology, Engineering and Mathematics (STEM) education to equip students with the skills and knowledge needed to face future challenges [2]. Although STEM is regarded as an interdisciplinary approach to instruction, mathematics is the underpinning foundation of an effective STEM education [3]. Mathematical knowledge is vital in developing 21st-century skills such as critical thinking, problem-solving, and analytical thinking. In addition, using mathematical knowledge, one can comprehend, predict and describe a phenomenon [3]. Developing strong mathematics knowledge requires mastery of all the learning areas, such as numbers, geometry, statistics, and algebra.

However, the TIMSS 2019 report shows that Malaysian Form Two students obtained unsatisfactory results with an average score of 461 in their mathematics assessment, which is still below the intermediate international benchmark [4]. This result reveals that although Malaysian students have a basic knowledge of mathematics, they cannot apply it in various situations [5]. Meanwhile, Malaysian students obtained the lowest score of 456 for the content area of algebra, which covers 30% of the overall assessment [5]. This result indicates the inability of Malaysian Form Two students to apply algebraic models to solve real-world problems and to explain relationships involving algebraic concepts [4]. Algebra is one of the core domains in the mathematics curriculum [6]. The knowledge of algebra and its application is pivotal to comprehension related to other mathematics content areas [7]. The mastery of algebraic concepts influences students' performance in advanced mathematics. [8]. Despite the importance of this domain, algebra is still known as a challenging topic to grasp in the secondary school curriculum [9]. Hence, further studies are required to identify an effective instructional strategy to ensure the successful learning of algebra.

Most of the studies involving mobile learning have reported the use of this approach in various subjects in tertiary education [10 – 14]. However, few studies have reported the use of this approach in secondary school mathematics education. Therefore, to the best of our knowledge, this is the first study that intends to develop a mobile learning module for the topics of Form Two algebra. The findings of this study will suggest an alternative strategy to assist students and teachers in tackling the deficiencies in the teaching and learning of algebra. This paper discusses the first phase of the study, the analysis phase, which determines the need to develop the mobile-learning module. The followings are the research questions of the study:

  i.   What are the teachers' perceptions of students' difficulties level in learning Form Two algebra?
  ii. What are the teachers' perceptions of the hindering factors in learning the topics of Form Two algebra?
  iii. What are the teachers' perceptions of implementing a mobile learning module for Form Two algebra?
  iv. What are the teachers' perceptions of the features to be implemented in the mobile learning module for Form Two algebra?

2. LITERATURE REVIEW

Many researchers have studied the difficulties faced by students in learning algebra. Past studies have reported that students struggle in remembering and recalling the concepts of algebra [15]. Students are also weak in applying basic operations involving algebra [9, 16, 17]. Besides that, students also misinterpreted algebraic statements with false representations[9, 18]. Studies also found that students face difficulties applying algebraic reasoning to compare and make logical arguments involving problem-solving questions [19]. Typically, these studies reveal a lack of fundamental knowledge and skills in algebra, which causes

various challenges in learning this domain and requires prompt action.

A study by [7] found that the conventional teaching approach demotivates students in learning algebra. In contrast, past research has shown that technology integration can engage students more actively and reduce rote learning [20, 21]. Technology integration also enables teachers to carry out differentiated instructions suitable for the needs and abilities of students [22]. The use of technology also allows learning materials to be easily accessible by both teachers and students [23]. Apart from that, the diversity of educational technology tools permit teaching and learning to be implemented interactively and creatively across all levels [24]. Furthermore, technology-integrated learning can now occur in virtual classrooms because of the rapid advancement of the internet and digital technologies [25].

As a result of this, mobile learning has been drawing greater attention among educators [26, 27. 28]. In this digital era, mobile devices such as smartphones, tablets, and netbooks are commonly available among students and teachers, thus allowing them to engage in teaching and learning activities from anywhere at any time [29]. Mobile learning can also support 21st-century learning, which encompasses critical thinking, creativity, collaboration, and communication among students [26], 30. Mobile learning also provides flexibility for students to carry out independent learning, which enables them to control the learning contents conveniently to suit their own pace [31]. Implementing mobile learning also allows teachers to create differentiated learning instructions appropriate to students' ability and assess their learning progress dynamically [30]. Past studies have also shown that the use of mobile learning can improve students' performance [32] and interest in learning mathematics [10], 14]. Moreover, the continuous development of digital tools suitable for mathematics education ensures mobile learning as a viable instructional strategy to enhance the learning experience.

3. METHODOLOGY

This study adopted a quantitative research design using a developmental approach. For this, the study uses the ADDIE instructional design model to develop the mobile-learning module for the topics of Form Two algebra. This paper, however, reports on the first phase of the ADDIE model, which is the analysis phase. In this phase, the study employs a survey method to determine the underlying problems in learning algebra and the possible solution using a mobile learning approach.

The analysis phase of this study involves 178 out of a population of 312 lower secondary mathematics teachers from Kuala Lumpur, Malaysia, who were selected using a simple random sampling technique. The data was collected using an online questionnaire adapted from [15, 33], comprising four sections. The first section of this questionnaire consists of multiple-choice items to obtain the background of respondents. The second section employs a five-point Likert scale, ranging from (1) very easy to (5) very difficult, to determine the level of difficulties students face in learning the topics under the domain of algebra. Meanwhile, the following items in sections (ii), (iii) and (iv) use a five-

point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. These sections aim to obtain the perception of respondents on the hindering factors in learning Form Two algebra, implementation of mobile-learning module and the features for developing the mobile-learning module, respectively.

Before the data collection, the instrument's content validity was established by a panel of five experts, comprising mathematics lecturers and experts in module development. Subsequently, the researcher carried out a pilot study using 33 samples to determine the reliability of the questionnaire based on Cronbach's alpha value. Table 1 shows the Cronbach's alpha value obtained.

Table 1: Cronbach's alpha value for each section of the questionnaire

	Section	Cronbach's alpha value	Reliability level
II(a)	The difficulty level in learning topics of Form Two algebra	0.734	Reliable
II(b)	Hindering factors in learning the topics of Form Two algebra	0.928	Very highly reliable
III	Perceptions on implementing mobile-learning module for Form Two algebra	0.950	Very highly reliable
IV	The suggestion of features for the mobile learning module for Form Two algebra	0.930	Very highly reliable

The findings indicate that values of Cronbach's alpha are more than 0.6, which is reliable according to [34]. This questionnaire was distributed to the samples through their official email. The data collected were analyzed using descriptive statistics, namely percentages, and computed using the Statistical Package for Social Sciences (SPSS) software. The percentages calculated based on respondents' ratings provide a more precise and clear idea of the distribution of responses for each item.

4. RESULTS

According to the findings, 178 lower secondary mathematics teachers participated in this study, with 83.7% of them are female, and 16.3% are male. The results show that 74.7% of the teachers possess a Bachelor's degree while 15.7% possess a Diploma in Teaching. In comparison, 6.2% have a Master's degree, and the remaining 3.4% have a teaching certificate as their highest academic qualification. Furthermore, the findings on teaching experience reveal that 33.1% of the teachers had more than 15 years of experience, followed by 30.9% of those with 10 to 14 years of experience, and 28.1% of those with five to nine years of experience and 7.9% had less than five years of teaching experience. Furthermore, based on the teachers' ICT literacy, 91.6% of them responded that they had high ICT literacy meanwhile 8.4% of them had moderate ICT literacy.

Figure 1 shows the teachers' perception of students' difficulty in learning Form Two algebra topics. According to the

results, 91.0% of teachers agreed that Factorisation and Algebraic Fraction are the most difficult for students to master in Form Two algebra, followed by Algebraic Formulae (70.8%), Speed and Acceleration (52.8%), Gradient of a Straight Line (51.2%), Graphs of Functions (42.7%), and Coordinates (36.5%).
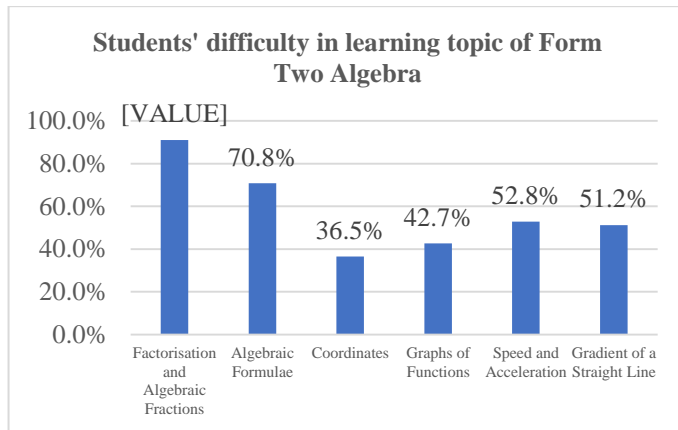

Figure 1: Teachers' perceptions of students' difficulty in learning topics of Form Two algebra.

Regarding teachers' perception of the hindering factors in learning the topics of Form Two algebra, the findings showed that 94.4% of teachers agreed that students have difficulties representing mathematical statements in mathematical terms. In addition, the result also indicates that students face difficulties in problem-solving involving algebraic terms (94.4%), misinterpret the concepts involving algebraic terms (93.8%), and face problems in computing algebra (93.2%). The findings also reveal that teachers agreed that students face difficulties analyzing information involving algebraic terms (91.6%). Additionally, 91.0% of them decided that students could not visualize the concepts taught. Moreover, students cannot relate the lesson to daily life applications (91.0%), and students have difficulties in creating relationships between algebraic terms (90.4%). Furthermore, findings showed that teachers moderately agreed to a lack of online learning resources based on the new Secondary School Standard Curriculum syllabus (82.0%) and interactive materials to support teaching and learning activities (80.9%).

Based on teachers' perceptions of implementing mobile learning modules for Form Two algebra, the findings revealed that 94.4% of teachers agreed that mobile learning modules could provide interactive teaching and learning experiences for students. In addition, 93.8% of teachers agreed that the mobile learning module offers an opportunity for blended learning. Furthermore, 93.3% of teachers agreed that the mobile learning module could increase students' interest in learning and enable students to search for relevant information using an online platform. Meanwhile, 92.7% of teachers agreed that the mobile learning module allows students to learn from anywhere. In comparison, 91.5% agreed that the mobile-learning module could support students at multiple paces in learning. Thus, as a whole, there

is a high agreement among teachers on implementing mobile learning modules for Form Two algebra (90.5%).

Meanwhile, the findings of teachers' perception on the learning skills to be implemented in the mobile-learning module for Form Two algebra revealed that there is a high agreement on using procedural skills (93.8%), conceptual skills (93.8) and problem-solving skills (92.7%). Meanwhile, the findings on learning activities showed that there is a high agreement on using online quizzes (96.0%), educational games (91.1%), using the internet to find information (90.4%) and moderate agreement on implementing group discussion (78.6%). The findings on learning materials showed that 96.1% of teachers agreed on using quick notes, followed by online quizzes (94.4%) and online videos (93.2%). Next, the findings on evaluation methods showed that 97.2% of teachers agreed on using individual assignments, followed by 96.7% agreeing for quizzes, 92.7% agreeing for formative assessment and 91.0% agreeing for self-reflection checklist.

5. DISCUSSION

Based on the need analysis results, it was discovered that, among the six topics in the algebra domain, teachers agreed that the topic of Factorisation and Algebraic Fractions is the most challenging topic to be mastered by Form Two students. This topic covers one of the essential knowledge and skills involving algebra: the expansion and factorization of algebraic expressions. This topic also covers the laws of basic arithmetic operations involving algebraic expressions and algebraic fractions. This finding parallels the study done by [9], which highlighted that students often have misconceptions related to incorrect use of the distributive property. This result is also consistent with the study by [17], which stated that students often use wrong process skills in the expansion and factorization of algebraic expressions.

Besides that, the result of the need analysis also shows that there are various difficulties students face that hinder them in successfully learning the topic of algebra. For example, the result shows that students face problems in computation algebraic terms and visualizing the concepts. This result indicates that students are unable to recall the conceptual knowledge and procedural knowledge involving algebra. The finding is consistent with the study by [15], which reported that students faced difficulties mastering conceptual and procedural knowledge in algebra, which influenced their ability to remember and recall the concepts learned. Meanwhile, [16] stated that students often make errors in algebraic computations and require concrete learning material to visualize the ideas.

Next, the results also showed that students have difficulties representing mathematical statements into mathematical terms and often misinterpret the concepts. Aside from that, the findings revealed that students struggle with relating algebra to real-life situations and creating a relationship between algebraic terms. Typically, this shows that students are still unable to apply algebraic knowledge and conceptual understanding to solve problems. This finding parallels the study done by [18], which stated that students' low proficiencies on algebraic notions cause them to be poor in

interpreting and translating worded statements into an algebraic representation.

Meanwhile, the findings show that students face difficulties solving problems involving algebraic terms and analyzing information involving algebraic terms. Furthermore, these findings indicate that students are generally poor in using algebraic knowledge and skills to observe and make logical deductions involving non-routine problems. This finding agrees with the study by [35, 36], which reported that students were poor in algebraic problem solving due to low mastery of conceptual and procedural knowledge. As a whole, all these findings show that students' cognitive skills competency, namely knowledge, application, and reasoning, are still insufficient.

The findings also showed that teachers agreed that students were facing difficulties due to a lack of online and interactive learning resources to support teaching and learning of algebra. This finding is supported by [7], who agree that the visuals in online learning materials can assist students in exploring algebraic concepts that are difficult to teach using conventional teaching and learning approaches. This finding clearly shows a need to develop an online-based learning module integrated with interactive features to help students learn algebra.

Besides that, the findings also showed a high level of agreement on teachers' acceptance of implementing mobile learning modules for the topics of Form Two algebra. Teachers agreed that the use of a mobile-learning approach has various advantages, such as being able to integrate interactive learning materials, being able to use them in a blended learning environment, and being able to increase learning interest among students. Teachers also agree that mobile learning will promote personalized learning as students can learn based on their own pace and necessity from anywhere at any time.

This need analysis is also carried out to obtain teachers' perceptions on the suggestion of features that need to be included in developing the mobile-learning module for Form Two algebra. These features are categorized according to four components: learning skills, learning activities, learning materials, and evaluation methods. Teachers highly agreed that the mobile-learning module should emphasize procedural skills, conceptual skills, and problem-solving skills for the learning skills. These findings parallel the results in the previous section, which highlighted that students have difficulties with computations involving algebraic expressions and algebraic problem-solving. For the learning activities, teachers highly agree that the mobile-learning module should include activities using online quizzes, educational games, and searching for information via the internet.

Meanwhile, teachers highly agreed that the mobile learning module should include quick notes, quizzes, and online videos for the learning materials. These are in line with the findings from the previous section, which showed that mobile learning enables students to engage in learning activities using interactive learning materials. Finally, the results show that teachers agreed that the mobile learning module should assess students' understanding using individual assignments, formative assessments, and self-reflection checklists for the

evaluation methods. Again, these findings parallel the results obtained in the previous section, which stated that mobile learning could provide a personalized learning experience for students.

6. CONCLUSION

The findings of this need analysis provide factual information for developing a mobile-learning module for the topics of Form Two algebra. Based on teachers' perception, it is found that Factorisation and Algebraic Fractions is the most challenging topic to be mastered by students in Form Two algebra. The findings also revealed various factors related to students' incompetency in cognitive skills, namely, knowledge, application, and reasoning, which hinder the effective learning of Form Two algebra. Among those factors are difficulties in representing mathematical statements into mathematical terms and problem-solving involving algebraic terms. This need analysis also revealed a high agreement among teachers that mobile learning modules enable students to learn interactively and support blended-learning environments. Besides that, teachers also highly agreed to include the features of learning skills that emphasize procedural, conceptual, and problem-solving skills. In addition, teachers also agreed that the mobile learning module includes learning activities such as online quizzes, educational games, and internet browsing. Meanwhile, the module should also have learning materials such as quick notes and online videos. The module should also include evaluations using individual assignments, formative assessments, and self-reflection checklists. In conclusion, there is undoubtedly a need to develop a mobile-learning module for Factorisation and Algebraic Fraction to enhance students' achievement and learning experience in this topic.

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