

# Hi-Math Mobile App: Effectiveness in Improving Arithmetic Skills of Primary School Students

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**Abstract:** *In this digital age, mobile technology has the potential to improve the primary students' motivation who are not motivated and having the difficulties to concentrate in Mathematical classroom. A mobile app called Hi-Math was designed and developed as a game-based learning aid that is fun to learn the mathematical skills especially the arithmetic for the Year 3 students. This paper reports the result of a research done to investigate the effectiveness of a mobile app named Hi-Math to improve the arithmetic skills of Year 3 students. 44 students of Year 3 from three schools from Kedah, experienced the Hi-Math mobile app, and answered a set of questions to measure their arithmetic operation skills before and after the intervention. The findings suggest that all of the respondents agreed that the Hi-Math mobile app is usable and suitable in helping them to learn Mathematics in an easier way. Through the intervention of the mobile app, the students are able to answer arithmetic questions easily and it can motivate the students and increase their awareness of how fun mathematics can be. This mobile app is also beneficial to the parents and the teachers to assist the students in learning the arithmetic operations.*

**Keywords:** *Hi-Math; arithmetic; Year 3; primary; Mathematics.*

## I. INTRODUCTION

To learn arithmetic, it is important for the students to learn arithmetic is mastering mathematical concepts of addition, subtraction, multiplication and division. The instantaneous recalled of the mathematical concepts has been a requirement to answer the mathematical questions correctly. However, it is argued that the mathematic classes should revolve around making meaning (just as with nontraditional approaches to reading and writing) and promote thinking rather than rule-memorizing [1]. The students should be encouraged to understand the underlying concepts and be able to apply them in any situation.

Research done on Mathematics reported that this subject in school is the most difficult and dislike by the students [2]. Large numbers of students have not acquired the basic skills they need in mathematics [3] [4]. As a result, many students were reported to face difficulties in mathematics [2]. If teaching and learning process is not equally effective for all students, the difficulties in acquiring mathematic skills by the students could get worse. Understanding students' difficulties in mathematics skills needed in problem solving is one of the ways to assist this group of students Mathematics is a subject that is hard to learn for some students [2].

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Hi-Math is a mobile app that is designed and developed specifically for the Year 3 students to provide a fun way to learn arithmetic operations. Mathematical concepts such as addition, subtraction, multiplication, and division, are illustrated and animated in such way that it will attract the students to learn. Hi-Math is designed and developed using various elements of multimedia such as text, graphic, audio and animation and its purpose is to motivate the students to practice and improve their arithmetic operational skills. It will be a great way for students to brush up on their math facts and math vocabulary. This mathematical mobile app also has assessments, feedback and scores to emphasize the students' understanding.

## II. RELATED WORK

Mathematics classrooms should revolve around making meaning (just as with non-traditional approaches to reading and writing) and promote thinking rather than rule-memorizing [5]. In Malaysia, Mathematics is a core subject must be taken in primary school examination in Malaysia named UPSR (UjianPencapaianSekolahRendah or Primary Schooling Achievement Tests) [6]. Besides, the Malaysian Examination Board also reported that more than 35% of primary school student have failed the course [7]. This is due to the low motivation level to learn Mathematics and also that the students perceived Mathematics as a difficult to understand the subject [8].

Teaching and learning mathematics have faced many challenges worldwide that either in delivery methods and student's participations [9]. There are four main problems with the current learning systems in Malaysia that inspires us to work on this research. The problems mainly dwell around the current learning environments which is 'chalk and talk' which is too rigid that limit the students' potential in their learning process [10]. This is sometimes made the 21st century students who are friendly with computers and mobile phones to be bored and uninterested. In this case, the teacher should find new digital teaching aids to teach the students [10].

The generation of students now is digital natives. They grew up with digital technologies. Teachers have to solve important issues related to the adaptation of the learning process towards students who have different learning styles and new requirements for teaching and learning. Gamification is one of the mobile educational approaches and techniques that increase motivation and engagement of learners [11]. According Zichermann& Cunningham [12], the process of game-thinking and game mechanics engage users and solve problems.

Researchers claim that there are many advantages of using games in the form of mobile application in teaching mathematical. Game-based learning aids create a meaning situation for the students to learn. It motivates them to learn as the students are able to participate and enjoy their learning at their own will [13]. It also provides opportunities for building self-concept and developing positive attitudes towards the subject, through reducing the fear of failure and error [14]. This method also improves the students' learning as greater learning occurs and opportunities to test intuitive ideas and problem solving strategies increases [15]. The game-based learning allows the students to operate at different levels of thinking and it has the opportunity to carry out diagnosis and assessment of learning in a non-threatening situation [16]. It was stated that, gamification in Mathematic classrooms positively affect the students' emotional state, stimulate their interest and promote active learning [16]. Not only have that, research claimed that the students expressed increased motivation and engagement as well as improves their learning [17].

A comparative analysis was conducted to Hi-Math with 3 existing Mathematical apps that cover the arithmetic operation techniques for Malaysian students. The comparison analysis suggested that the mobile apps have animated tutorial that could help the students learn arithmetic operation techniques properly. Hi-Math is designed to have all the important features such as animated tutorial, narration, background music, game-mode assessment (exercise), feedback and score. Table 1 shows the comparison of different functions or features of the existing mobile apps with Hi-Math.

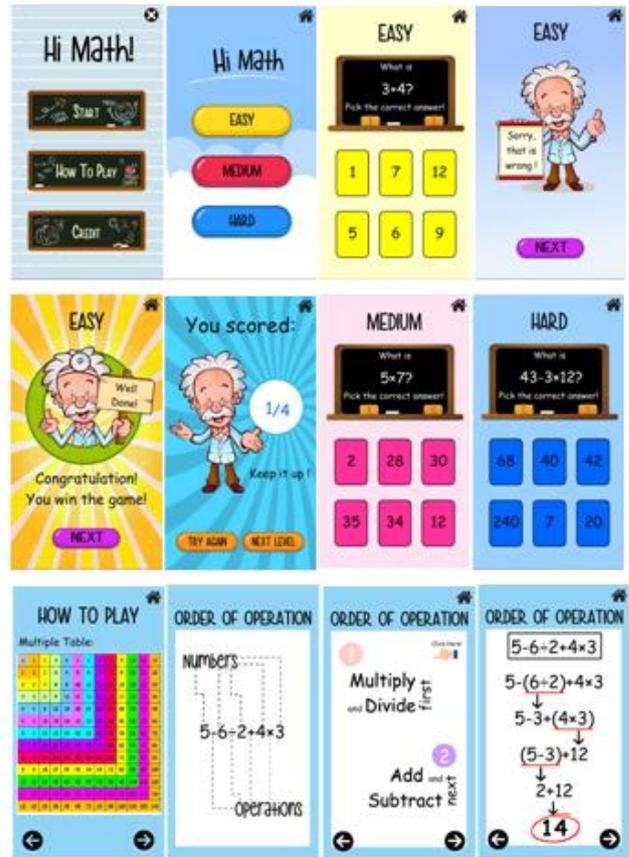
**Table. 1 Comparison of different Mathematics mobile app with Hi-Math**

Apps	Background Music	Narration	Graphic	Animated Tutorial	Assessment	Timing	Feedback	Score
Math Game	/	x	x	x	/	/	x	/
Math it! Logic Game	/	x	x	x	/	/	x	/
Space Math Hero	/	/	/	x	/	x	x	/
Hi-Math	/	/	/	/	/	x	/	/

**III. HI-MATH MOBILE APP**

Hi-Math is a game-based mobile learning app that aims to improve the arithmetic skills of Year 3 primary students. It is developed for the reason that the traditional learning of the arithmetic operation techniques is abstract, difficult to visualize and often slower compared to the animated learning techniques in Hi-Math. Not only that it has step-to-step animation tutorials of the multiplication techniques, it also provides a redundant audio explanation of the techniques. It illustrates four arithmetic operations, namely addition, sub-

traction, multiplication and division. The content covers the animated tutorial, and assessments. There are three assessment levels; easy, intermediate and hard. It also gives feedback to the students whether the answer given by a student is correct or incorrect, and the student can try again if the answer is incorrect. The app will also display the scores of the assessments. The mobile app is designed to have all the important features such as animated tutorial, narration, background music, assessment, feedback and score. Not only that, it is designed and developed in the form of game-based approach to improve the students' understanding and to make the learning process enjoyable. Figure 1 illustrates the interfaces of the Hi-Math mobile app.



**Fig. 1 Hi-Math mobile app interfaces**

The Hi-Math app was developed using Adobe Flash with ActionScript 3.0. The lesson content for this app was developed based on the Integrated Primary School Curriculum (KBSR) syllabus provided by the Ministry of Education. The user interface of the app is designed using the appropriate color, font and graphics that are suitable for primary students.

**IV. RESEARCH METHODOLOGY**

The purpose of this research is to assist the Year 3 students to improve their mathematical skills. In order to do that, a mobile app called Hi-Math was designed and developed using Adobe Animate, and ActionScript3.0 as a game-based learning aid to learn the mathematical skills especially the arithmetic operations for the Year 3 students.



**Sample**

This research involves 44 students of Year 3 from three schools from Kedah who experienced the Hi-Math mobile app. They are all 9 years old and they are homogenous in terms of educational background. They have no knowledge or experience in using the Hi-Math mobile app to learn Mathematics.

**Instruments**

The respondents were assigned to Hi-Math mobile app that is aimed to motivate the students to practice and improve their arithmetic operational skills. The instruments used for this research were a pre-test and a posttest to measure the respondents' arithmetic operation skills. The test consists of 12 Mathematical questions that include addition, subtraction, multiplication and division. The question falls into the range of easy, intermediate and hard. The questions are based on the Integrated Primary School Curriculum (KBSR) Level 1 syllabus provided by the Ministry of Education. The respondents were also given an opinion questionnaire after the intervention to evaluate the whether the mobile app has contributed to the objectives.

**Research Procedure**

The respondents were given the pretest questions for 15 minutes prior to the intervention. Then, they were assigned the Hi-Math mobile app individually, and they have used the mobile app for one hour to experience the learning content. For the evaluation phase, the respondents were given fifteen minutes to answer the post-test questions. The data that were collected were then analyzed statistically and the final report was generated.

**V. FINDINGS**

A sample of 44 students of Year 3 from three schools in Kedah was conveniently chosen to be the respondents for this study. They are 9 years old. For the purpose of evaluation, the respondents were given a set of pre-post Mathematic test and user evaluation questionnaire. The pre-post Mathematic test was to measure their arithmetic operations skills of addition, subtraction, multiplication and division and the questionnaire were to evaluate their opinion of the Mathematic learning and Hi-Math mobile app. The analyses of the data were carried out through descriptive statistical techniques. Table 2 illustrates the descriptive analysis of the respondents' demographic information.

**Table. 2 Respondents' demographic information**

Information	Distribution	Percentage (%)
Gender	Male	20 45.5
	Female	24 54.5

The analysis described that 24 female and 20 male students of age 9 were chosen as respondents for this project. They experienced the Hi-Math mobile app and answered twelve arithmetic operation questions. They were given the pre-test prior to the intervention and the post-test after the intervention. The scores are obtained to measure the respondents Mathematics skill of arithmetic operations. The findings of the descriptive analysis suggested that the mean value for the pre-test scores is 6.14 and the mean value of the post-test scores is 10.81 indicating that the students performed better during the post-test which is after the Hi-Math intervention.

The descriptive analysis of the test scores is depicted in Table 3.

**Table. 3 Descriptive analysis of Mathematics test scores**

Item	Pre-test		Item	Post-test	
	Correct (%)	Wrong (%)		Correct (%)	Wrong (%)
Pre 1	44 (100.0)	0 (0.0)	Post 1	44 (100.0)	0 (0.0)
Pre 2	41 (99.2)	3 (6.8)	Post 2	44 (100.0)	0 (0.0)
Pre 3	39 (88.6)	5 (11.4)	Post 3	42 (95.5)	2 (4.5)
Pre 4	28 (63.6)	16 (36.4)	Post 4	40 (90.9)	4 (9.1)
Pre 5	37 (84.1)	7 (15.9)	Post 5	42 (95.5)	2 (4.5)
Pre 6	23 (52.3)	21 (47.7)	Post 6	42 (95.5)	2 (4.5)
Pre 7	10 (22.7)	34 (77.3)	Post 7	37 (84.1)	7 (15.9)
Pre 8	10 (22.7)	34 (77.3)	Post 8	40 (90.9)	4 (9.1)
Pre 9	26 (59.1)	18 (40.9)	Post 9	39 (88.6)	5 (11.4)
Pre 10	1 (2.3)	43 (97.7)	Post 10	35 (79.5)	9 (20.5)
Pre 11	8 (18.2)	38 (81.8)	Post 11	37 (84.1)	7 (15.9)
Pre 12	3 (6.8)	41 (93.2)	Post 12	34 (77.3)	10 (22.7)

The descriptive analysis indicates that all the mean scores for the post-test are relatively higher than the mean scores of the pretest. The mean scores determined that students obtained higher test scores after they have used the Hi-Math mobile app. This means that the students were more successful in their arithmetic operations when they learn using Hi-Math mobile app.



To further investigate, a paired t-Test was conducted to see if there is a significant difference in the arithmetic test between the pre-test and the post-test scores. Table 4 indicated the paired sample T-Test analysis result of these scores to describe the significance value.

**Table. 4 Mathematics test pre-post test scores analysis**

Items	Paired Differences			Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	
Pair 1: Pre1 - Post1	.000	0.00	0.00	1.00
Pair 2: Pre2 - Post2	-.068	.255	.038	.083
Pair 3: Pre3 - Post3	-.068	.398	.060	.262
Pair 4: Pre4 - Post4	-.273	.499	.075	.001
Pair 5: Pre5 - Post5	-.114	.387	.058	.058
Pair 6: Pre6 - Post6	-.432	.501	.076	.000
Pair 7: Pre7 - Post7	-.614	.493	.074	.000
Pair 8: Pre8 - Post8	-.682	.471	.071	.000
Pair 9: Pre9 - Post9	-.295	.509	.077	.000
Pair 10: Pre10 - Post10	-.773	.424	.064	.000
Pair 11: Pre11 - Post11	-.659	.479	.072	.000
Pair 12: Pre12 - Post12	-.705	.553	.083	.000

As for the paired-sample T-Test analysis, the mean of the post-test scores (Total  $\bar{x}$  post = 0.901) are relatively higher than pre-test scores (Total  $\bar{x}$  pre = 0.511). The p-value for the Pair 4, 6, 7, 8, 9, 10, 11, and 12 is less than 0.05 indicating that there is a significance difference between the pre-test scores and the post-test scores. These higher post-test mean scores indicated that the respondents are able to answer all the questions in the Mathematics test better after the Hi-Math intervention.

Overall, it can be concluded that the respondents agreed that after they have experienced the Hi-Math, their understanding of arithmetic operations improved as it is a fun way to learn Mathematic skills. They have given positive feedback that Hi-Math motivates them and the workshop has been positively successful in fulfilling the intended outcomes.

**VI. DISCUSSION AND CONCLUSION**

Hi-Math is a mobile app that was developed for Year 3 Mathematic learning, evidently enhances the learning process of the arithmetic operators namely; addition, subtraction, multiplication and division. The content which was delivered using the redundancy of multimedia elements that employed animated tutorial and game-based assessments. It enables the primary students who are digital natives to learn at their own pace and allows them to understand the learning content better. Giving them the control over the lesson and the time required to complete each lessons, provided them the confidence and keep them motivated throughout the entire lesson. This game-based learning aid acts as an alternative way to classroom 'chalk and talk' and textbook learning.

By using such approach, the students' comprehension and interest in the Mathematic subject are cultivated efficiently. At the same time, it also nurture enthusiasm and motivation to further improve the literacy of Mathematics among the young students who are just starting to learn and apply various problem solving techniques.

In addition, Hi-Math provided a multi-genre tutorial space in a game-based approach that engages and draws students into a different interaction with Mathematics. It also appeals to multiple intelligences as it provides embedded mixture of visual (text) and audio (sound, music or voice) modalities that enables students to learn through their preferred modality. The students were able to learn Mathematics while creating and integrating 'schema' to understand better and freely at their own will. They may repeat the content as many times as they want for them to understand each step of arithmetic operations better. The combinations of multimedia elements in Hi-Math that adapted the gamification approach offered the students a welcome change from routine lectures in the classroom and also arouse their interest in learning various types of modalities. In addition, it also helps the teacher or parents to teach the abstract concepts of arithmetic operations' precedence which were difficult to explain verbally.

The game-based learning aid in the form of mobile application such as HiMath creates a meaning situation for the students to learn Mathematics. It motivates them to learn as they are able to control the content and the learning by their own and at their own will. Not only that it provides opportunities for building self-concept and developing positive attitudes towards the subject, it also reduces the fear of failure and error. This eventually will boost their motivation and confidence in learning the subject. This game-based learning also allows the students to operate at different levels of thinking and learning in a non-threatening situation. Overall, this research also supports the claim that gamification in form of mobile application for Mathematic classrooms positively improve the students' learning and promote active learning.

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