

## Chapter 15

### Multiple-eMath

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#### ABSTRACT

Researchers found that competency in mastering numbers and system of equations was a strong predictor of proficiency in mathematics. Many students never develop rich understandings of numbers nor notational forms to represent ideas. Developing such understandings and representational skills is a long-term focus of the mathematics education community as well as researchers. Students who lack in the area of number sense will also lack in mathematical proficiency. In view of the importance of mastering the number sense, this study aims to develop a mathematical tool, Multiple-eMath to engage users through self-paced exploration on number sense and equations. Multiple-eMath is a mathematical tool providing exploration for arithmetic operations based on BODMAS rule. It also features step-by-step solutions to trigonometric, exponential, logarithmic, inequality, factorial, decimal, percentage, fractional, square and square root equations (enhanced from Flexi-EQ Solver and Experiential Equation Solver). The users have the experience to master the arithmetic operations of any form in a fun way. The researcher interviewed ten respondents to elicit their opinions on the use of Multiple-eMath. The respondents were asked in detail the design, comments and suggestions on the Multiple-eMath. The interview findings showed that majority of the respondents provided their positive feedbacks on their use of Multiple-eMath. Five respondents shared the same view that Multiple-eMath is attractive, nice and promotes thinking skills. The novelty of this tool includes the application of 21<sup>st</sup> century skills such as the mastery of critical thinking skills.

**Key Words:** arithmetic operations, BODMAS rule, number sense, equations, 21<sup>st</sup> century skills.

## 1. INTRODUCTION

Number sense is broadly defined as the ability to understand, approximate, and manipulate numerical quantities. Number sense plays important role in the development of number system skills. Learners use number systems to label, rank order, quantify and measure almost every aspect of the world (Brannon, 2006). Number system can be used in calculating all sorts of equations ranging from displacement of bus, velocity of car, acceleration of aircraft, momentum of objects and many more.

The development of number sense is a critical foundation for high-level mathematics (Boaler, 2015). Students who lack in the area of number sense will also lack in mathematical proficiency because of their deficit in conceptual understanding. (Gaillard, 2018). Researchers found that competency in mastering numbers and system of equations is a strong predictor of later proficiency in mathematics.

Many students never develop rich understandings of numbers, such as rational number nor facility with notational forms to represent these ideas, such as fractions and decimal notations. Developing such understandings and representational facility is a long-term focus of the mathematics education community as well as researchers. The ability to solve number and linear equations is the foundation for mastering many concepts in Algebra, but there is evidence that user's understanding of the concept is often minimal (Gary & Johan, 2014).

In view of the above statement of problems, the objective of this study is to develop mathematical tool, Multiple-eMath which aims to engage users through self-paced exploration on arithmetic operations. This study is greatly needed as many studies emphasize urgent need to develop a broader and deeper view of algebra learning among students (Kaput, 2008; Lee & Freiman, 2004), as well as arithmetic learning. Moreover, number equations and algebraic equations solving skills are critical predictor and important to lead the success in mathematics.

## 2. LITERATURE REVIEW

According to Schiffman and Laski (2018), students who use advanced arithmetic strategies, such as count-on and decomposition are more accurate when solving arithmetic problems. Additionally, they are more likely to later have higher levels of mathematics achievement. Therefore, acquisition of numerical knowledge and understanding of numerical information are crucial for adapting to the changing demands of our digital society.

On the other hand, Zamarian (2018) assessed arithmetic learning for old and young individuals through a training experiment. Zamarian assessed age-related effects of training intensity, prior arithmetic competence, and neuropsychological variables on the acquisition of new arithmetic knowledge and on the transfer of the knowledge. Outcome was assessed after 3 months training. The study indicates that arithmetic learning depends on the training intensity as well as on person-related factors including individual age, arithmetic competence before training, memory, and executive functions.

Gray and Tall (1994) investigated how low-achieving and high-achieving students solve number problems. The findings showed that more successful students were able to flexibly think through the mathematical problems, while the low-achieving students used more complicated strategies to solve problems. Low-achieving students were not low-achieving solely because they knew less but were low-achieving because they did not use numbers flexibly. Further, Jordan et al. (2010) reported that counting, number relationships,

and basic operations emerged as uniquely predictive constructs within number sense for success in mathematics learning.

### 3. METHODOLOGY

This study interviewed ten respondents to elicit their opinions on the use of Multiple-eMath. All the respondents were secondary school students ranging from age 13 to 15. They have explored Multiple-eMath and practiced on arithmetic operations based on BODMAS rule, exponential, logarithmic, decimal, percentage, fractional, square and square root equations. They were exposed to the use of Multiple-eMath for one month. They were asked in detail the design, comments and suggestions on the Multiple-eMath. This study comprehended standardized open-ended interviews whereby the wording and sequence of questions are determined in advance. The interviews were planned with reference to the interview-based research procedures.

The guidelines for the conduct of interviews (Cohen, et al, 2018) were strictly followed. Among these, the researcher avoids saying 'I want to know' as the interviewee is doing a favour and not being interrogated. Besides this, the non-verbal communication, eye contact, signs of anxiety and showing respect are consistently considered throughout the interviews by the researcher. The duration for each interview session was approximately 15 minutes. The interviews were recorded, transcribed, analyzed and finally reported. As for the validation purpose, the data were cross-checked to ensure the accuracy, consistency and reliability undertaken.

#### Multiple-eMath

Multiple-eMath is a mathematical tool providing exploration for arithmetic operations based on BODMAS rule. It also features step-by-step solutions to trigonometric, exponential, logarithmic, inequality, factorial, decimal, percentage, fractional, square and square root equations (enhanced from Flexi-EQ Solver and Experiential Equation Solver). The users have the experience to master the arithmetic operations of any form in a fun way.

In mathematics classroom, learners can get confused with all the operations symbols mean when they study on arithmetic operations. The possible alternative solution is using Multiple-eMath whereby the users can manipulate the arithmetic operations starting from the basics so that everything can make sense to them. When they get to learn how to solve equations, they get to practice step-by-step solutions to their mathematics problems and the whole procedures to handle the problems. They can think of it like a puzzle and work hard to solve the puzzle. Multiple-eMath allows the users to get exposure on the solutions to all kinds of mathematics arithmetic operations problems, from the very fundamental to a complex form. The mastery of arithmetic operations skills can be significant predictor for the success in mathematics achievement.

The novelty of this product includes the application of 21<sup>st</sup> century skills such as the mastery of critical thinking skills. The user will start his turn by constructing any equation based on the available tiles. He will need to think critically and look for a strategic location to construct the equation because the marks will be calculated for the equation formed. Some cells offer multipliers such as double cell score, triple cell score, double equation score and triple equation score. He will need to construct the appropriate equation at strategic location to maximize the marks scored.

The second user will also construct any equation from the available tiles based on the location where the first user has formed equation. The marks will also be calculated for the equation formed by the second user. The objective of playing is to gain the highest

marks to win the game. Player can construct any mathematics equation involving arithmetic operations based on BODMAS rule, trigonometric, exponential, logarithmic, inequality, factorial, decimal, percentage, fractional, square and square root on the board. Each number tile and function tile will carry different marks. The aim is to obtain the highest marks based on the mathematics equation formed by using the tiles. Examples of the interfaces for Multiple-eMath are shown in Figure 1.

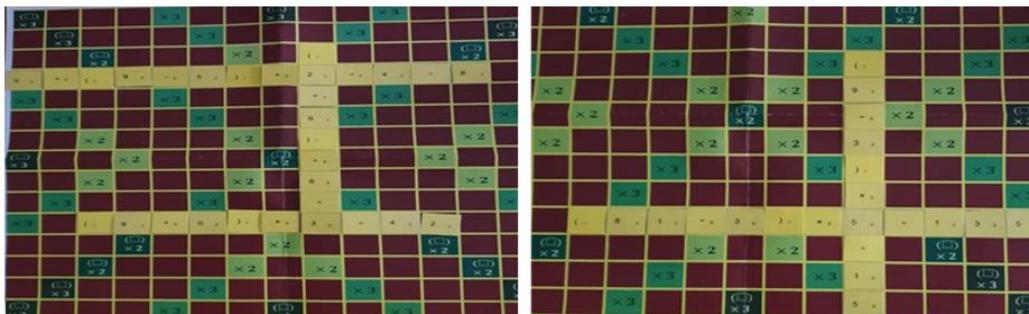


Figure 4: Arithmetic Operations Based on BODMAS Rule

#### 4. FEEDBACK ON THE USE OF MULTIPLE-EMATH

The respondents consisted of four male and six female students. More female students were reported to participate as compared to male students. All the respondents were interviewed to give opinions on the design, comments and suggestions for Multiple-eMath.

When interviewed about the design of Multiple-eMath, five respondents viewed it as “attractive, nice and promote thinking skills especially critical thinking skill”. The sentiments shared by these respondents are as follows:

*“Multiple-eMath is attractive and colourful. I like to play with this interface, but I need to think hard in order to win.”*

*“It is nice and easy to play without much confusion. However, it requires me to think critically”*

*“The display is clear and nice to play. I love to play with my friends as it helps to polish my thinking.”*

*“I think smart when I want to form the equation. I am targeting triple equation score or double equation score to form my equation.”*

*“Multiple-eMath attracts me to participate actively to practice on equation. I really think while performing the equation.”*

Based on the comments received from ten respondents, majority of the respondents provided their positive feedbacks on their use of Multiple-eMath. Below are few examples of the constructive comments made by the respondents.

*“I like this tool as it helps me to practice many mathematics equations which I face problems to understand, especially exponential and logarithmic equations.”*

*“Multiple-eMath helps me practice mathematics equations in a fun and motivating way.”*

*"I like to play with my friends when I free because it can help me improve my mathematical skills."*

*"I have improved my mathematics knowledge in fraction, index and logarithm through the practice to form many different equations."*

*"I can perform arithmetic operations based on BODMAS rule through Multiple-eMath. My friend helps to correct me if I use the BODMAS rule wrong."*

*"It is very useful to form varieties of mathematics equations."*

*"It helps me understand mathematics equations better."*

Multiple-eMath can be further improved to facilitate the respondents' learning, especially in the remedial level so that they can improve their mathematical skills. Few suggestions from the respondents comprise easy-handling and more practical tips. Below are the examples of respondents' suggestions. Three respondents suggested:

*"It is very helpful to me, but I need more practice to master the knowledge. I will need some practical tips."*

*"Useful but the tiles are light and easily flied away by a fan, perhaps magnetic or heavier tiles will be used."*

*"The quality of the tiles and board can be appropriately improved to ease the handling of Multiple-eMath."*

## 5. CONCLUSION

The teaching of algebra and systems of equations is difficult and always will be. Persistence is essential, together with a realization that pupils' difficulties may well be reasonable ones. We should be prepared to admit to our pupils that the subject is at times difficult. This can reduce the pupil's sense of inadequacy when faced with an apparently intractable problem and also serve to remind us that algebra and systems of equations are not always obvious - even to ourselves. The use of Multiple-eMath can help to assist them in solving systems of equations, supported by majority positive feedbacks on the use of Multiple-eMath.

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