Leveraging Emoji-Based Diagrammatic Approaches to Enhance Algebra Learning in Lower Secondary Education

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ABSTRACT

The aim of this study is to evaluate the understanding and effectiveness of the Emoji Diagrammatic Approach (EDA) in the teaching and learning of algebra among Form One students in a Malaysian secondary school. A total of 26 students were involved in this action research. Data were collected using pre-tests, post-tests, student feedback forms, and document analysis. Prior to the main study, a pilot test involving five students was conducted to validate and refine the research instruments.The results indicate notable improvements in students' understanding and engagement in learning algebra through the use of emojis in diagrammatic representations. Quantitative data were analysed using Microsoft Excel and SPSS software (version 17.0). The findings suggest that the Emoji Diagrammatic Approach not only enhances students' conceptual understanding but also stimulates interest and logical thinking in algebraic problem-solving. Moreover, the study highlights the importance of thorough teacher preparation, including assessing students' prior knowledge and carefully planning lesson delivery to ensure the approach is effectively implemented. This approach offers promising potential as an innovative strategy in teaching mathematics, particularly in addressing common difficulties faced by lower secondary students in algebra.

Keywords: Emoji, Diagrammatic Approach, Algebra, Teaching Strategies, Student Improvement, Mathematics Education

INTRODUCTION

Mathematics is a vital subject that supports the development of critical and logical thinking; however, many students globally dislikes mathematics and stay away from many careers related to Mathematics. Algebra plays a crucial role in secondary education, as it introduces abstract thinking and logical reasoning through symbols that represent varying quantities. Educators believe that mathematics, fosters logical thinking skills, with algebra introducing abstract concepts through symbols that represent varying quantities. Algebra strengthens these logic skills and introduces abstract thinking. It gets across the idea that symbols such as x and y stand for numbers that vary and can be used to find missing pieces of a mathematical or real-life puzzle or to understand changing relationships. Experts agree that transitioning from arithmetic to algebra is one of the toughest challenges for students (Lee & Hsu, 2023).Teachers, especially those working with secondary school students, must be aware of how kids think and reason algebraically. Students aged 7 to 15 are typically at Piaget's formal operational stage of cognitive development, where representations can simplify complex concepts (Zhao & Zhao, 2023). Algebraic thinking starts with the concrete experience of numbers and progresses to generalization and abstract thinking through activities (Mason, 2008; Radford & Sabena, 2015). Algebraic thinking often involves the process of generalizing arithmetic operations, and as it gets more complex, it deals with unknown quantities.

LITERATURE REVIEW

Algebra can be viewed as a language of mathematics; playing a major role for students' opportunities to pursue many different types of education in a modern society. Various studies shows that in mathematics teaching, diagrams are a frequently used tool in Singapore (Beckmann, 2004) and Japan (Murata, 2008), the two countries

known for their superior mathematics achievement compared to global standards (Hiebert, 2003; Lowrie, 2020). The purpose of diagrams is not only to assist students in performing operations but also to help them select appropriate operations and understand their conceptual relevance (Wang & Chen, 2023).This study discusses how diagrams can enhance mathematical understanding and problem-solving skills among students and enhance their cognitive abilities (Kerslake & Noyes, 2022). Diagram is helpful and powerful tool in mathematics thinking. Despite their benefits, there remains a lack of affirmation regarding their use in connecting existing knowledge with new concepts. Visual representations, such as diagrams and illustrations, can help students understand complex concepts in many STEM domains (Rau, 2017).

Problem statement

Traditionally, algebra is introduced to students after they have thoroughly understood the basic mathematics knowledge and grasped the fundamental arithmetic skills (Curriculum Development Centre, 2003). According to a study conducted by foreign mathematics researchers, the topic of algebra is the hardest to learn and understand. The problem with algebra arises because the concepts and principles are too abstract for most of the pupils, and they find difficulties in relating the subject content to everyday life (Smith & Jones, 2022). In my experience teaching Form One students, I found it difficult to help them understand concepts such as simplifying expressions involving like and unlike terms. For example simplifying the expression, $x + y - 2x$. Students facing difficulties in simplifying with like and unlike terms. Besides that, by using the ordinary approach such as using text books, work book, various examples and explanations still unable them to master the algebraic expression. With advance of technology such as AI (Artificial Intelligent) able to create various diagrams, which will help in terms of time consuming and achievements especially in learning of mathematics among school going children.

Pilot Study

A pilot study was conducted among Form One students as a test of the research instruments and protocol before the full-scale study. A small group of approximately five students was selected for this initial phase, with the primary aim of identifying potential problem areas and shortcomings. This preliminary testing was crucial in ensuring that any issues with the research design were addressed early on, allowing for refinements that would increase the reliability and effectiveness of the full study (Muasya & Mulwa, 2023) explain that pilot studies help evaluate research methods, particularly research instruments, to enhance the reliability and validity of data. Pilot studies are valuable for evaluating research methods and instruments, which contributes to the reliability and validity of the data collected. They help researchers assess how well the instruments will work in practice, and they ensure the clarity and appropriateness of the questions or tasks (Westlund & Stuart,2017). In addition, pilot studies allow researchers to assess participant engagement and the feasibility of the full study, ultimately leading to more accurate and trustworthy results.

Research objectives

1.5.1 Understanding created among form one students with the usage of emoji diagram in teaching and learning algebra.

1.5.2 Effectiveness of emoji approach diagram in simplifying algebraic expression involving four like and unlike terms among form one students.

1.5.3 Evaluate the impact of emoji diagrams on student motivation and engagement in learning algebraic concepts.

Research question

1.6.1 To identify at what extend the understanding created among form one student by emoji diagram approach in teaching and learning algebra.

1.6.2 To identify the effectiveness of emoji diagram approach in simplifying algebra expression involving four like and unlike terms among form one students.

1.6.3 How do emoji diagrams influence student motivation and engagement in learning algebraic concepts among Form One students?

METHODOLOGY

This is a quantitative research study particularly adopted action research design(Ott & Longnecker, 2010). The lower secondary school students' learning in algebraic expressions were investigated with respect to their achievement with help of emoji diagram approach. Total of 26 samples involved in this study. Data were collected by using basic instruments such as pre- test and post-test. Data were analyzed using descriptive statistics over a two-week period between tests.The number of items in pre-test and post-test are same which has total of 9 items in each test. The coefficients of items in post-test changed compared to the pre-test. The different coefficients in items adopted in order to know their understanding. Only addition, subtraction and combined operations involved in this study. The collected data was analysed using descriptive statistics(Mills & Gay, 2019). Overall time gap between pre-test and post-test two weeks. A senior teacher whom have 20 years' experience in teaching of mathematics conducted the emoji diagram approach while teaching algebra. The teacher conducted the algebra class by using various emoji symbol to represent the unknown of x and y In this study, we adopt(Winn, 1987). Winn's definition that a diagram is a 2-dimensional, visual representation, that exploits spatial layout in a meaningful way, enabling complex processes and structures to be represented comprehensively. Only two types of emoji diagram approach used in this study.

Analyze and Results

Prior to the administration of the pre-test, students were introduced to the concepts of like terms and unlike terms, as shown in Table 1. Subsequently, students were required to identify whether the given expressions or terms represented like or unlike terms. Mastery of like and unlike terms enables students to perform basic algebraic operations in accordance with mathematical rules.

Table 1: Identification like and unlike terms

expression	like	unlike
$3x$ and $5\ x$	Some students perceived both concepts as being the same, indicating a lack of clear differentiation.	This indicates that students often focused on numerical values alone and did not attend to the symbolic meaning of the variable x.
$3y$ and $2\ x$	Some students incorrectly assumed that $3y$ and $2x$ were the same, indicating difficulty in distinguishing variables in algebraic terms.	Some students interpreted x and y merely as different alphabets, similar to letters used in language subjects, rather than as variables representing different quantities.

Table 2 shows sample of Emoji Diagrammatical Approach (EDA) conducted among the 26 participants all of them from form 1. The EDA make students understand that same emoji can be added and subtracted. Similarly like terms and unlike terms can be simplify by adding and subtracting. Various of EDA patterns and sequence helps students understand the concept of algebra.

Pre-test conducted before the EDA. Post-test conducted after the EDA. The time gap between the two test was two weeks. The results of pre-test and post-test summarized as shown in Table 3. Five is the maximum score in pre-test while 9 in post-test. Mean of post-test almost 3.5 times larger than the mean of pre-test.

Table 2: Emoji Diagrammatical Approach (EDA)

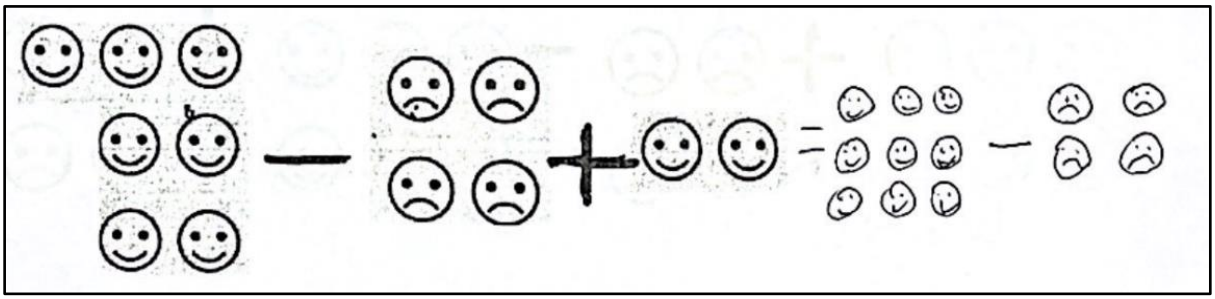


Table 3: Results of pre-test and post-test.

	N	Minimum	Maximum	Mean	Std. Deviation
PRETEST	26	0	5	2.31	1.668
POSTEST	26	6	9	8.23	1.142
Valid N (list wise)	26				

DISCUSSIONS AND CONCLUSIONS

Over the years, various teaching and learning approaches have been developed to enhance students' understanding of mathematics, including the use of **diagrammatic representations**. Previous studies have shown that visual methods such as diagrams significantly improve students' ability to solve problems and retain concepts more effectively.

In this study, students initially made numerous errors in simplifying algebraic expressions, as reflected in Table 3 and observed in their pre-test workings. However, after the implementation of the Emoji Diagrammatic Approach (EDA) in teaching algebra—particularly in simplifying like and unlike terms—students showed marked improvement. The EDA enabled students to visualise the relationships between algebraic terms, thereby strengthening their conceptual understanding.

The post-test results further support this improvement, with almost all participants scoring between **6 and 9**, compared to the **0 to 5** range in the pre-test. This demonstrates that EDA not only enhances comprehension but also builds meaningful connections in learning algebra.

From a researcher's perspective, it was deeply satisfying to witness students express genuine enjoyment in learning algebra—many even stated that they "love studying algebra" after experiencing the EDA lessons. This shift in attitude highlights the motivational impact of innovative, student-centered teaching strategies.

As educators, we should move beyond traditional textbook-based methods and instead adopt visual and interactive approaches such as EDA before introducing abstract symbols like x or y. Teaching algebra directly through symbols may overwhelm students and hinder their appreciation of the underlying logic and structure of algebra.

In conclusion, the findings of this study indicate that the Emoji Diagrammatic Approach can serve as an effective and engaging pedagogical tool for enhancing students' understanding and interest in algebra. Nevertheless, further research on a larger scale is recommended to gain deeper insights into students' thinking processes and to validate the broader applicability of this approach in diverse classroom contexts.

Over the years, various learning approaches and strategies have been developed to improve student's ability including the use of diagrams. Studies have shown that using diagrams has many benefits, including helping students succeed in problem-solving. Students made a lot of mistakes and errors in simplifying algebraic

expressions as shown in Table 4 and Table 5, see their workings or solutions at pre-test. After the EDA used in classroom while teaching algebra, especially on the skills simplifying like and unlike terms. The EDA helps the students to understand better the concept of like terms and unlike terms. Almost all the participants score between 6 and 9 in post-test compare to the pre-test 0 and 5. EDA creates connections in learning algebra. As research i have gained a lot of satisfaction hearing students say they love to study algebra. As teachers we cannot approach students with the plain idea of teaching algebra with the text book and practice. Approach them with diagrammatical method before introducing algebra such as x or y. Teaching algebra directly will kill their ability to understands the beauty of algebra. More study needed in larger scale in order to get deeper and clearer thinking of students regarding algebraic.

Research on *relational thinking* shows that algebraic understanding develops from students' understanding of arithmetic operations and relationships (e.g., addend and sum concepts) and how they generalize these ideas symbolically. Such understanding is fundamental to tasks involving the combination of like terms, which depend on students' ability to identify structural equivalence within algebraic expressions beyond the application of routine procedures (Kızıltoprak & Yavuzsoy Köse, 2017). Following the implementation of EDA in classroom instruction, noticeable improvements in students' learning outcomes were evident. The integration of icon emojis, which are familiar to students through their daily life experiences, supported meaningful learning and contributed to improved understanding among Form 1 students in the targeted school.

In summary, our results suggest that EDA self-explanation helps students acquire conceptual knowledge of algebra in the early stages of their learning, as the students are transitioning from informal (non-algebraic) to formal (algebraic) ways of solving.

Table 4: Students actual workings base on pre-test and post-test.

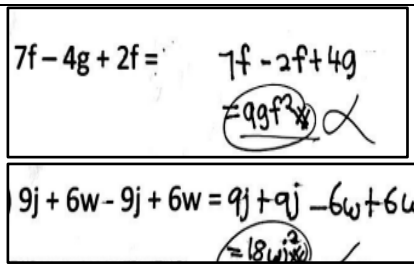
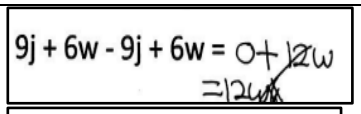
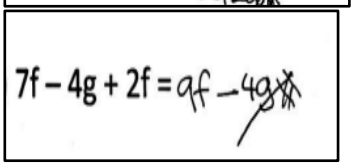
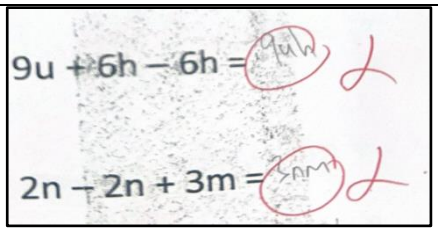
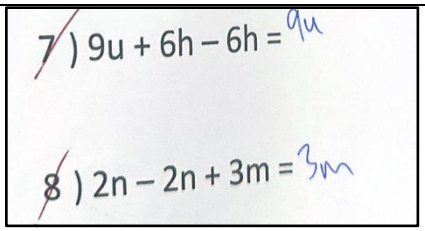
Num	Pre-test	Post-test	Notes
1		 	Students demonstrated an improved ability to simplify algebraic expressions correctly, as EDA helped them understand the concept of like and unlike terms.

Table 5: Students actual workings base on pre-test and post-test.

Num	Pre-test	Post-test	Notes
2			Students demonstrated an improved ability to simplify algebraic expressions correctly, as EDA helped them understand the concept of like and unlike terms.

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