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Developing Algebra is Fun Application to Enhance Academic Achievement and Motivation among Tenth-Grade Students Using the ADDIE Model

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Abstract

This study develops the "Algebra Is Fun Application" (AIFA) to improve academic performance and motivation among tenth-grade level students in algebra through the ADDIE model. The needs of the students were examined with the help of the open-ended questionnaire in order to understand the difficulties in seeing the algebraic concepts, learning style types they like, and to what degree they may receive the benefits of using interactive tools like GeoGebra, Photo Math, and educational games like Kahoot. It was found that there were problems in the interpretation of symbols and abstract ideas, poor problem-solving abilities, and graphing problems, which indicates that realistic uses should be used. The application was thus created to have simplified explanations, interactive exercises, visual aids, and diversified content such as video, practical examples and real-life problem solving, in three stages: before, during, and after lesson. The originality of such a research is that a number of interactive technologies were used as one application with specific respect to the Jordanian tenth-grade students, and the contribution of such a study is that it will help to provide a practical model of improving achievement, motivation, and analytical thinking in mathematics teaching and enrich the sphere of social sciences by connecting technology and the performance of students.

Keywords: Interactive Algebra, Academic Achievement, Student Motivation, ADDIE Model, GeoGebra, Photo Math

Introduction

One of the supports of secondary education is algebra that lays grounds on the further development of mathematical concepts and their practical implementation in daily life. Although it is an essential topic, abstract ideas, poor problem solving and graphical representation are some of the areas where many students fail because they tend to memorize the information as opposed to understanding abstract concepts (Tarigan et al.,

2023). As digital education rapidly increases, interactive applications have become useful to facilitate self-paced and interactive learning experience. They enable the delivery of content in various ways in the form of videos, practical activities, and educational games, thus boosting the motivation and engagement of students (Rayan & Watted, 2024).

The Jordanian context has also not been characterized by the promotion of technological tools in the teaching of mathematics, which is why the level of achievement is deteriorating due to the outcomes of the PISA test (OECD, 2022; World Bank, 2022). Students of the tenth grade specifically experience lifelong difficulties with the understanding of algebraic concepts and work with symbols and variables, the ability to solve real-life problems, and the lack of motivation to learn (Altakhayneh, 2020; Yaseen and Loum, 2021).

To overcome these problems this work will use the Algebra Is Fun Application (AIFA) that was developed with the ADDIE model where analysis, design, and development stages would be used. The novelty of the current study is that it integrates the use of tools to form a single application, namely GeoGebra, Photo Math, and Kahoot, that could be used by tenth-grade students in Jordan. It adds value as it shows how interactive technology can improve achievement, motivation and problem-solving skills in algebra contributing to the social science arena by correlating educational technology with student performance and motivation.

Literature Review

Interactive learning means the approaches that involve students directly in the learning process directly by solving problems or discussing questions or using digital media (Azra, 2025). In this regard, educational technology is critical offering new tools to present information, instant evaluation, and increase the engagement of students. GeoGebra and Photo Math are some of the tools that enable visualization of algebraic concepts and step-by-step solution of equations (Sebsibe & Abdella, 2025). It has also been demonstrated that educational games like Kahoot can be motivating and more engaging as they stimulate and engage the students instantly in a positive competition (Rayan & Watted, 2024). ADDIE model is one of the most popular approaches to designing digital education and involves five primary steps: Analysis: Determining the needs of learners, their challenges and the learning goals. Design: Pushing forward instruction plans containing content, activities, and assessment procedures. Development: Planning and development of digital educational goods and interactive applications. Implementation: The program will be implemented with the target students. Assessment: gauging the success of the program and assessing the progress (Ding and Toran, 2024; International Journal of E-Learning, 2024). This paper will concentrate on the initial three phases so as to design and develop the AIFA application.

Problem of the Study

In Jordan, secondary schools have low levels of adopting technological tools in teaching algebra, which hinders the chances to enhance academic performance and motivate students more (Wafa'a, 2019; Mosa, 2021). According to the results of the PISA, the achievement of mathematics among the students of Jordan dropped to 361 points in 2022 (when compared to 400 points in 2018), which is lower than the average in the world (OECD, 2022). The rate of achievement in algebra among students is between 60 to 70 percent (World Bank, 2022).

Hardly any problems with grasping algebraic principles, working with symbols and variables, and solving real-world problems, poor problem-solving skills, and motivation problems can be identified in the 10th grade (Altakhayneh, 2020; Yaseen and Loum, 2021). Today, modern interactive applications are not being used as much as oral explanation and textbooks, which decreases the effectiveness of learning (Hamdan and Eyad, 2020; Szilagyi et al., 2022).
Although the advantages of educational technology are supported by the research, not all the studies have been done on the effect of interactive apps on the performance, motivation, and problem-solving abilities of students, particularly when the gender difference is taken into consideration (Abutayeh et al., 2022; Pan and Ke, 2023).
This problem highlights the urgent need for innovative digital solutions such as the AIFA application.

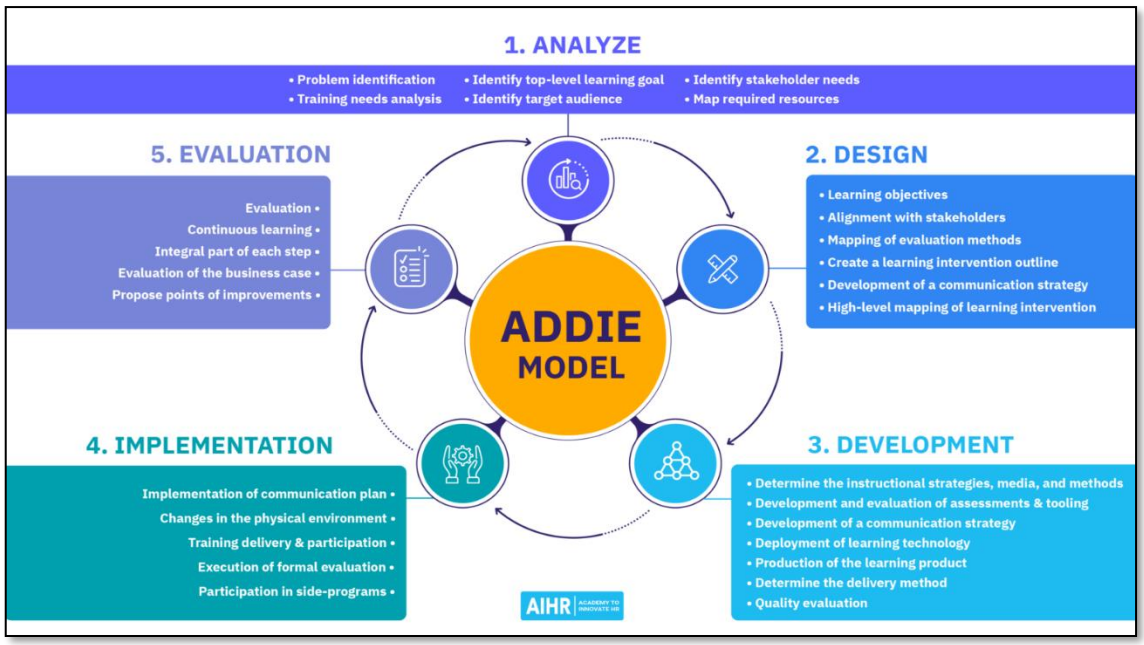

Figure 1: ADDIE Model

In this study, the ADDIE model was adopted, which is one of the most famous educational design models and is used to develop educational programs in an organized and effective manner. The model consists of five interconnected stages, but the current study focuses only on the first three stages, which are:

Analysis: It includes identifying learners' needs, analyzing the curriculum and content, studying the conceptual and procedural difficulties faced by tenth grade students in the subject of algebra, in addition to reviewing previous studies to determine the basic requirements for building the application.
Design: During which the educational plan for the application is developed, learning objectives are determined, the content structure is built, interactive activities and tests are designed, and the screens and interfaces are drawn in accordance with the analysis results.
Development: It includes producing digital content, developing educational media, integrating appropriate interactive tools such as GeoGebra, and generating the initial version of the application according to what was designed.

It should be noted that this study does not address the implementation and evaluation phases, as its scope is limited to explaining how to design and develop the Algebra Is Fun application based on the first three stages of the ADDIE model, without actually implementing the application or evaluating it within the environment.

Questions of the Study

The current study attempts to answer the main question: What key components of Algebra is Fun should be included to effectively support the learning of algebra concepts for 10th grade students?

Study' Limits

This study is limited by several aspects related to the process of developing the "Algebra Is Fun" application, as the development was limited to following the ADDIE model with its five stages, without benefiting from other design models that may provide deeper or alternative steps. The needs analysis also relied on an open-ended questionnaire directed to tenth grade students, which may limit the comprehensiveness of the data to represent all types of learners. The content developed within the application was limited to specific algebraic topics, which limits the possibility of generalizing the design to other mathematical branches. In addition, the application is designed to be compatible with devices common in Jordanian schools, which may reduce its ability to work efficiently in different technical environments. Thus, the results of the development process are related to the temporal, technical, and objective context in which it took place, and may differ if these factors differ.

Importance of the Study

The significance of the study is that it will bring to light how the Algebra Is Fun (AIFA) application can be used to increase learning of algebra among tenth grade learners, by increasing motivation, promoting achievement and learning problem-solving skills. The study also helps in demystifying the effect of interactive technologies on the motivation and engagement of students in the learning process, as well as offers insights that teachers, curriculum developers, and decision-makers can use in facilitating the use of technology in learning mathematics (Algebraic, 2023).

The research aims to also increase the academic level of the students, as the tool would give them interactive learning experiences, depending on modern technologies, including free equation-solving tools, train their skills in solving problems and applying scientific concepts, as well as support the learning environment of teachers using dynamic and interactive learning systems (Osypova and Tatochenko, 2021).

Conversely, the study will be able to improve the motivation of students by building their conceptual and practical knowledge of the topics of algebra and improving their grades, by successfully combining the AIFA application in the classroom with the right digital learning tools (Wibowo et al., 2023).The potential of interactive learning applications as holistic methods of education is also reflected in the study, as it will contribute to a better understanding of the practical effect of the latter in the classroom and guide the teachers on how to integrate technology in a manner that can positively influence learning in algebra and other subjects (Dean & Lima, 2022).

The novelty of this study is that it addresses the students of Jordanian high schools in the 10th grade, in a multicultural environment, and the systematic model of instruction design (ADDIE) to combine various interactive technologies into one application. Its input goes beyond mathematics education, and it provides a model that can be replicated in creating interactive educational tools that would enrich the social sciences through connecting technology, pedagogy and learner psychology..

Methodology

In the designing and developing of the Algebra Is Fun application in the tenth grade of students, the ADDIE model was used to carry out the study and adopt the descriptive-developmental approach (Branch, 2009; Molenda, 2022). The analysis step implied the investigation of the curricula and past research and examined the needs of the students through open-ended questionnaire of six questions to (20) students not part of the core sample to identify the challenges of the educational process and their preferences (Eryani et al., 2025). During the design stage, the overall application structure is determined, the interactive activities are created, and the screen layouts are constructed (Jingmiao, 2024). The production of digital content and the integration of interactive tools like GeoGebra and electronic tests were the next stage of the development process (Siregar, 2024). Lastly, the implementation and evaluation involved testing and revising the first version of the text to make sure that the content was good and students could relate to it (Dick et al., 2015; Huang, 2021). It is necessary to add that this research is not going to cover implementation and evaluation since it is focused on explaining how to design and develop the AIFA application and only on the first three stages of the ADDIE model.

Instruments of the Study

In order to fulfil the study objectives, use of the following tools was undertaken: i) Needs analysis questionnaire**:** It contained six open-ended questions, and it was given to 20 students in tenth grade who part of the main sample were not. The questionnaire was aimed at estimating the challenges students have with learning algebra concepts and solving problems, their favorite learning tools (videos, interactive applications, problem solving), how much they enjoy using digital learning tools like GeoGebra and Photo math, the way they are satisfied with their current teaching methods, and how educational games like Kahoot can help them to better understand algebra. The outcomes of such survey assisted me to determine the shortcomings of students, and the content and elements of the Algebra Is Fun application (Branch, 2009; Yanuarto and Hanum, 2025). ii) Pre- achievement and motivation tests: The forms of tests which are intended to gauge the level of students prior to applying any method of education and to detect the weak areas of students in algebra and motivation towards learning. Achievement tests comprised 10th -grade curriculum content in algebraic expressions, linear equations, polynomials and variables, exponents and roots, functions and graphs, and real-world problem solving. Subjective and objective goals, task value and self-efficacy, control beliefs and test anxiety were also measured with the help of the motivation questionnaire (Wibowo et al., 2023; Osypova and Tatochenko, 2021).

These tools have also been checked in terms of validity and reliability by reviewing the tools by experts as well as pre-test piloting in order to check the correctness of the outcome.

Instrument's Validity and Reliability

Validity is the extent to which a tool actually measures what it is intended to do (Punch, 1998). There were three types of validity that were studied in this research. To begin with, we looked at the legitimacy of the content. We offered the original questionnaire to seven academic practitioners who are the representatives of three universities in Jordan. The professionals ensured the clarity and relevance of items. They even analyzed the suitability of the products to the research objectives. The level of agreement they set was 80% among professionals. Then, we established whether the ratings of the questionnaire could be used to foresee the results or performance outcomes. Third, construct validity was tested whether the items measured the desired theoretical constructs under study. Reliability refers to the consistency of an instrument in measuring what it is expected to measure (Mohajan, 2017). Two methods were used to measure reliability. First, internal consistency was determined using Cronbach Alpha. The acceptable value of [?] is one of 0.70 (Surucu and Maslakci, 2020).

The reliability of the findings on 20 students was also considered by us. This was brought out during a period of 2 weeks, and Pearson correlation coefficients were computed. The usefulness of the tools employed in the study was ensured after conducting a review on the tools by academic experts and experts in the field of mathematics education and educational technology to ensure the questionnaires and tests gauge what they are supposed to measure as regards to aspects of students' achievement, motivation, and weaknesses. It also involved a preliminary experiment (Pilot Study) on a sample of 20 students not in the core sample as to the clarity, accuracy and appropriateness of the questions in the educational setting of the tenth grade.

Regarding reliability of the tools, internal consistency coefficients (Cronbachs alpha coefficient) were determined of the questionnaires and the tests and the results revealed that the questionnaires and the tests had high reliability levels which imply that the tools can generate the same and consistent results on remeasurement. The preliminary student testing also revealed that the difference in the scores was sufficient to be representative of the strengths of the tools to rank the students under different levels of achievement and motivation.

Table 1
Academic achievement test reliability values

Dimensions	Number of items	Cronbach's Alpha
Algebraic Expressions	4	0.899
Linear Equations	4	0.907
Polynomials, Exponents and Radical Expressions	4	0.900

Table 2
Mathematics Motivation Questionnaire Reliability Value

Dimensions	Number of items	Cronbach's Alpha
Internal goal orientation	6	0.875
Extrinsic goal orientation	6	0.887
Task value	6	0.906
Control beliefs about learning	6	0.913
Self-efficacy	5	0.879
Test anxiety	7	0.908

Educational Needs Analysis

Students' needs were measured and analysed through an open-ended questionnaire consisting of 6 questions that was distributed to 20 students outside the experimental sample, with the aim of identifying their actual difficulties and preferred educational methods. The questions were as follows:

1. What do you consider as the greatest difficulties you encounter in learning algebra, whether in the comprehension of concepts or the solving of problems?
2. Which do you prefer to learn algebra (e.g. learning through videos, problem-solving, using interactive applications)?
3. What do you believe would be the extent that you could learn about algebra better by utilizing a technological learning environment, like GeoGebra and Photo math?
4. To what extent are you pleased with the existing teaching techniques of algebra, textbook, and teaching materials?
5. What do you consider are your best subjects in algebra, and what are your weak areas or least favourite subjects in algebra?
6. How do you feel about interactive quizzes and game-based learning tools, like Kahoot, in terms of helping you to study algebra concepts?

Results of Needs Analysis

The responses of students led to the discovery of the most significant learning challenges and requirements as follows:

- Conceptual and algebraic symbol comprehension: 30 percent of the students noted that they had trouble with the symbols and variables, which is where simplified visual representation is necessary.
- Poor problem-solving skills: 25% reported that they have to work on problem-solving skills step by step.
- Difficulties with graphing: 20% of students need interactive visual tools such as GeoGebra.
- Absence of relation to real-life application: 15% demanded there to be examples that involve real-life application.
- Memorization without understanding: 10% of students emphasized the necessity to be able to develop a deep understanding.

It was also found that most students liked the interactive learning with the help of educational applications, video and educational games and feel the use of such tools like GeoGebra and Photo math may help to understand the algebra greatly.

This is a fundamental foundation on which the components and content of the application can be established, to find out that the needs of students are addressed, and effective learning takes place. According to these results, this application was programmed to contain simplified descriptions, interactive activities, visual aids, pedagogical games, and diversified content. Activities were designed in three phases including pre-lesson, in-lesson and post-lesson.

Design the Application using the ADDIE Model

The needs analysis results are converted into the system of structured learning provided through the design phase of the ADDIE model. At this phase, the learning objectives are established, learning content planned, and interactive learning activities will be undertaken

to make sure that the application of algebra is fun will resolve the challenges faced by students with algebra. What was used in this phase involves the following.

The Fundamental Elements of the Application

According to the needs analysis, the application will comprise the following elements:

- An easy example illustration and explanation of algebraic concepts in a step-by step manner.
- Giving interactive practical exercises and breaking them down into small units.
- Combine interactive tools such as GeoGebra to display concepts visually.
- Photo math helps to explain the steps to take when required.
- Educational games like Kahoot to promote engagement and immediate evaluation.
- Provide variety in the materials of educational videos, practical illustrations, and life examples.
- Modernizing the use of digital instructions in accordance with the requirements of the modern generation**.**

Topics Included

There were six fundamental topics chosen based on the Jordanian curriculum and findings of the needs analysis: Algebraic expression, Linear equations, polynomials, Exponents and roots, Functions and graphs, Solve real-life problems.

Educational Activities

The activities are planned in a three-stage process:

A. Pre-Lesson stage: Learn about concepts through videos and interactive materials on GeoGebra. Learning on own to solve equations and learn each step. Brief tests to determine preliminary knowledge.

B. In-Lesson stage: Solve problems on the interactive whiteboard using GeoGebra. Group activities to solve complex problems. Instant feedback from the teacher. Interactive quizzes via Kahoot to measure engagement and understanding**.**

C. Post-Lesson Stage: Revise ideas through GeoGebra to strengthen the knowledge. Post-test through Google Forms. Interactive activities to improve the skills of solving equations.

Development the Application

During the development stage, the design outline was transformed into a practical application using the ASP.NET platform, where the algebra educational units were built in the form of digital lessons that included introductory videos, pre- and post-tests, and interactive activities. The content was developed according to the specified structure, so that each topic includes: an educational video, a pre-test, a discussion activity, e-learning, and then a post-test. Dynamic interactive tools such as the GeoGebra API were also integrated to display graphs, and the application was linked to Kahoot tests to increase interaction, in addition to allowing the use of Photo Math within the application to help students gradually understand the solution steps.

A testing and immediate feedback system was also created, and a control panel was developed within the application to monitor students' progress, in addition to implementing quality tests that included examining interfaces and testing integration between tools, before

producing the initial version of the application (Prototype V1.0) in preparation for final review.

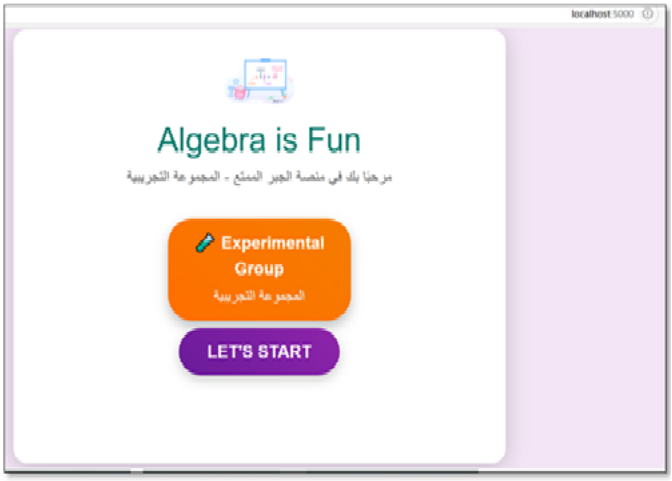

Figure 2: The Interface of the Application on ASP.NET

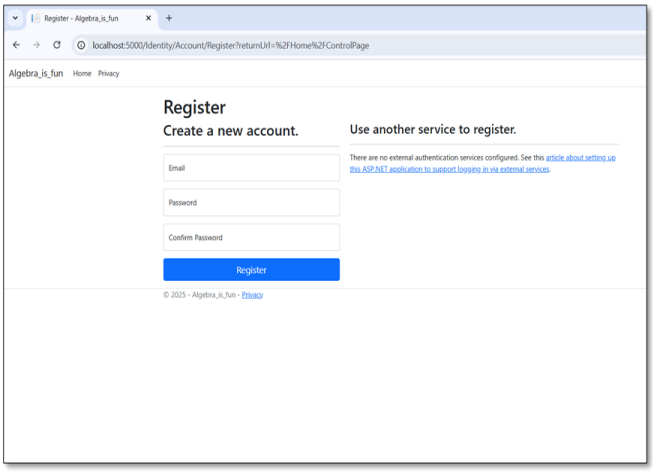

Figure 3: Create account

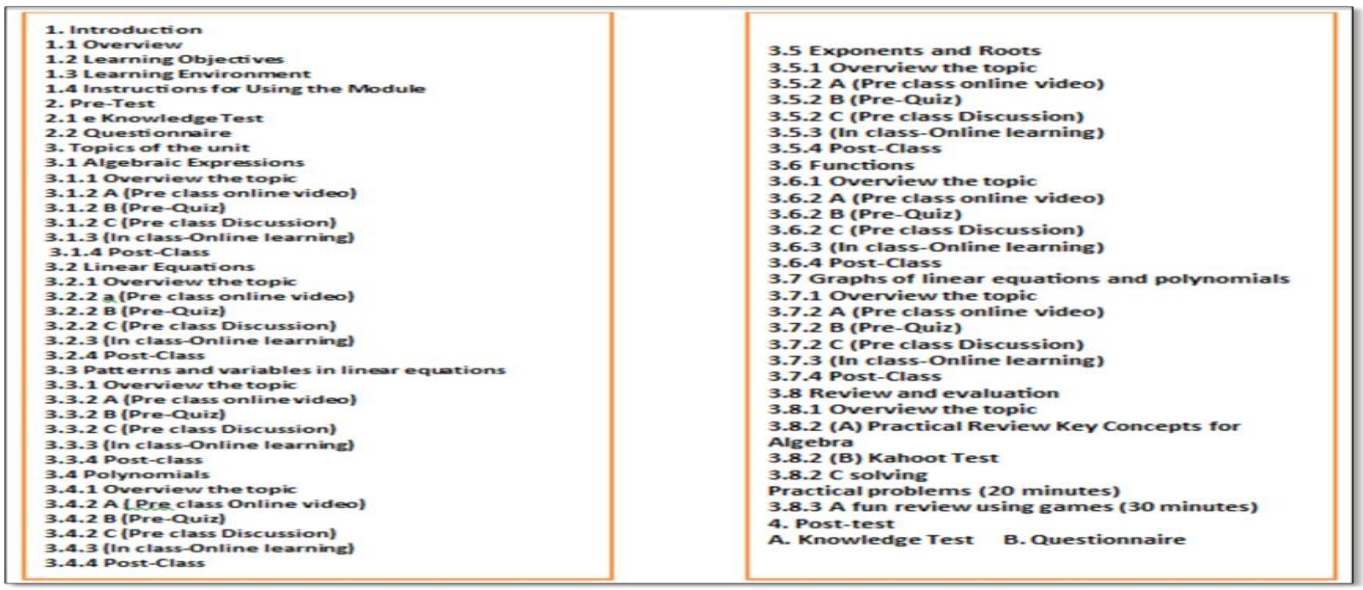

Figure 3: Outlines the application contents

Conclusion

The development of Algebra Is Fun (AIFA) application is a good move towards improving the learning experiences in Maths to match the requirements of the 21 st century students. The study relied on the ADDIE model to develop a methodological framework that starts with the analysis of the needs of the learners, continues with the designing of a clear educational framework, and ends with the development of a digital application incorporating the exact mathematical information with the modern interactive technologies.

The originality of the study is the combination of GeoGebra, Photo Math, and Kahoot into one application adapted to the needs of tenth-grade students in Jordan. It contributes to the possibility of creating an example that can be replicated in designing interactivity-based educational tools that can contribute to achievement, motivation, and problem-solving

abilities in mathematics education as well as provide information to curriculum developers and policymakers in social sciences.

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