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ENHANCING ELEMENTARY STUDENTS' MATHEMATICAL REPRESENTATION SKILLS THROUGH VBA-BASED DIGITAL LEARNING MEDIA IN MICROSOFT EXCEL

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Abstract

This study enhanced elementary school students' mathematical representation skills using visual basic for applications (VBA) in Microsoft Excel as a digital learning medium. VBA enables the development of interactive tools for learning fractions, making complex concepts more accessible. The study followed the Plomp research and development model to ensure systematic instructional design. The results indicated that the digital learning media effectively supported students' understanding of fractions because it significantly improves their mathematical representation abilities. The average pre-test score was 24.44%, although the post-test score increased to 82.22%, demonstrating substantial learning gains. Additionally, teacher responses (85%) classified the media as very practical, while student responses (79%) rated it as good. This improvement in students' mathematical representation skills occurred because the VBA-based digital learning media provided interactive, visual, and engaging learning experiences. The combination of dynamic visualizations and hands-on digital activities helped students better grasp fraction concepts. Based on these findings, the developed media is considered highly effective for teaching fractions in grade IV elementary school.

Keywords: Digital learning media, Elementary school students, Fraction concepts, Mathematical representation, VBA.

1. Introduction

Technology integration in education has become essential for enhancing learning quality [1-5]. Digital learning media can make abstract mathematical concepts more concrete and interactive, improving student engagement and comprehension. Various digital tools, such as GeoGebra and MATLAB, have been widely used to support mathematics learning [6-10]. One of the key benefits of digital media is its flexibility, allowing students to learn at their own pace and based on their individual needs.

One crucial skill in mathematics education is mathematical representation, which enables students to understand abstract concepts, communicate mathematical ideas, and solve problems effectively [11-14]. However, many elementary school students still struggle with representing mathematical concepts, particularly fractions, due to the dominance of conventional teaching methods and textbook-based learning. Most classroom instruction emphasizes procedural skills over conceptual understanding, making it difficult for students to grasp the deeper meaning of fractions [15-18].

To address these challenges, mathematics learning must leverage digital media to create a more engaging and effective learning experience. One promising technology for digital learning media development is Visual Basic for Applications (VBA) in Microsoft Excel. VBA allows educators to design interactive and dynamic learning materials, making complex mathematical concepts easier to understand. By integrating VBA macros, teachers can create interactive simulations tailored to students' needs, improving their conceptual understanding of fractions [19].

This study investigated the effectiveness of VBA-based digital learning media in Microsoft Excel in enhancing elementary school student's mathematical representation skills in fractions. The research follows the Plomp research and development model, consisting of three stages: preliminary research, prototyping, and assessment. The key contributions and novelty of this study include: (i) integrating VBA Macro technology into fraction learning for elementary school students; (ii) optimizing mathematical representation through digital simulations and interactive exercises; and (iii) developing easy-to-use and engaging digital learning media to support student learning. By leveraging VBA-based digital learning tools, this study aims to provide a more effective and interactive approach to teaching fractions, ultimately improving students' mathematical representation abilities and making learning more meaningful.

2. Literature review

We illustrate the key indicators of mathematical representation skills essential for students. These include visual representation (depicting concepts through images, tables, or graphs), symbolic representation (expressing concepts using mathematical symbols and models), verbal representation (explaining reasoning verbally), and numerical representation (expressing numbers in various forms) [20-24].

Mathematical representation is crucial in mathematics learning, allowing students to understand, communicate, and solve problems effectively. Research highlights that technology integration enhances mathematical representation skills

by enabling dynamic and interactive concept exploration, helping students connect different forms of representation. Digital media in mathematics learning provides an innovative solution to improve students' conceptual understanding.

Visual basic for applications (VBA) Macros in Microsoft Excel is a powerful tool for developing interactive learning media. VBA allows automated visualizations of graphs, tables, and symbols, making abstract mathematical concepts more accessible. As a widely used educational tool, Excel's automation features help present data systematically and interactively. Studies show that Excel-based learning media enhance students' critical thinking and problem-solving abilities. Therefore, integrating VBA Macro-based learning media into elementary mathematics education is an effective innovation for optimizing students' mathematical representation skills

3. Method

This study employs the research and development Plomp model, consisting of three phases: preliminary research, prototyping, and assessment.

(i) Preliminary research – It identifies problems and needs in teaching fractions using VBA Macro-based digital media in Microsoft Excel to enhance students' mathematical representation skill.

(ii) Prototyping – It develops a media prototype using storyboards and flowcharts, followed by evaluation from media experts, material experts, and students. Revisions are made based on feedback before classroom implementation.

(iii) Assessment – it evaluates the effectiveness of the developed media through pre- and post-test mathematical representation results and teacher and student feedback.

4. Results and Discussion

Figure 1 illustrates the steps for creating VBA-based digital learning media for fractions. Users start by selecting an image, such as a rectangle, circle, or triangle, which can be divided into equal parts. The shade part function allows users to highlight sections, and the fraction symbol check displays the fraction value based on the shaded area [25].

Figure 2 presents the media flow design through a storyboard. The first step involves selecting an image, such as a rectangle, which initially appears undivided. Next, users divide the image into sections by adjusting the denominator. The numerator can then be modified to shade specific parts of the image, visually representing fractions. The final step displays the fraction value based on the shaded portions. This structured storyboard ensures a systematic multimedia development process [26].

Figure 3 demonstrates the final digital learning media interface. The sun icon allows users to select an image, and clicking the green image button enlarges the selected shape. Up and down arrows adjust the numerator and denominator values, automatically updating the fraction's visual representation. The final display presents the fraction value alongside its visual form. This VBA-based digital media enhances learning engagement and comprehension [27].

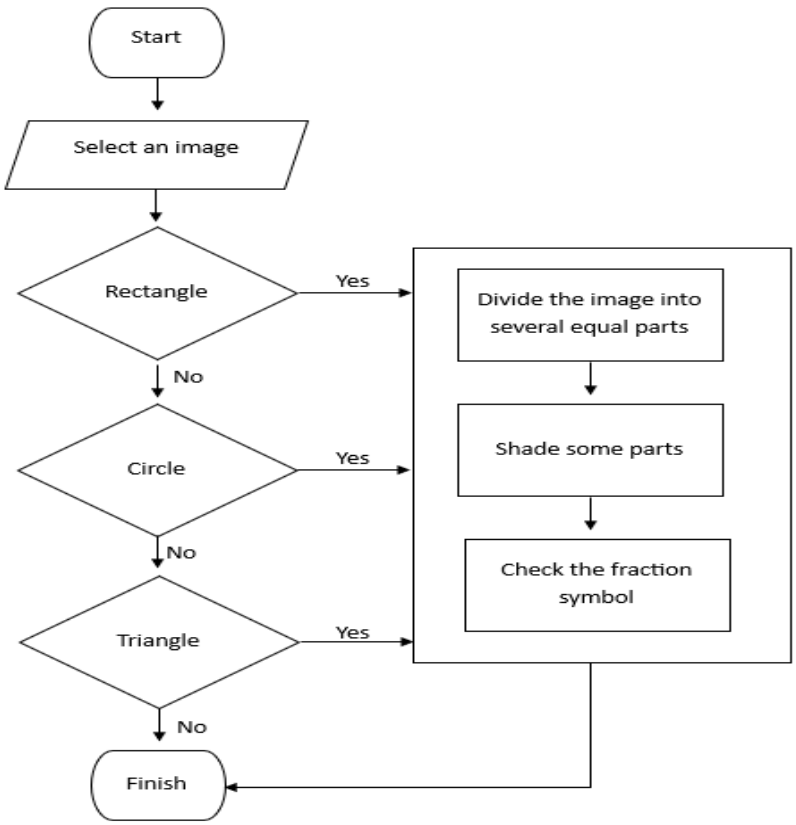

Fig. 1. Digital learning media flowchart for fraction concept material.

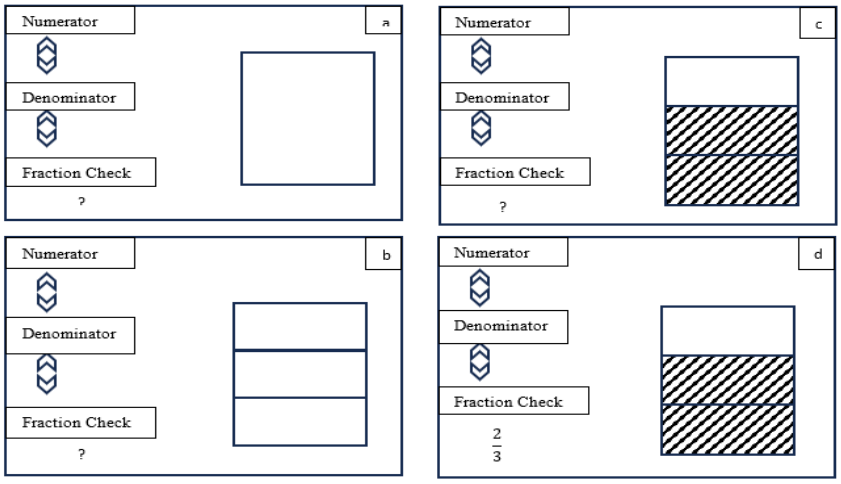

Fig. 2. VBA-based digital learning media storyboard with fraction concepts: (a) select image, (b) portion pictures, (c) darkness the section, and (d) check fractions symbol.

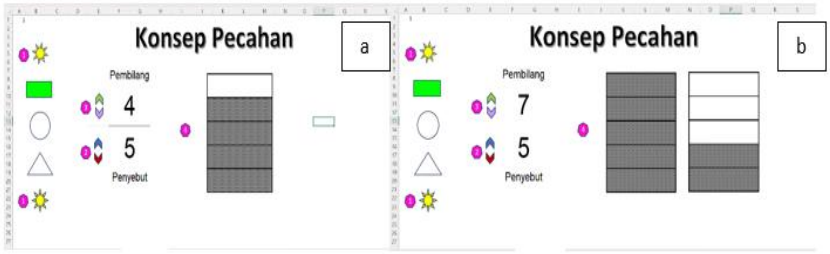

Fig. 3. VBA-based digital learning media display. (a) true fraction, (b) non-true fraction.

The media prototype was validated by experts, teachers, and students before classroom implementation. Detailed information for the statistical analysis is explained elsewhere [28-32]. Pre-test and post-test measured students' mathematical representation improvement. The pre-test average score of 24.44% increased to 82.22% in the post-test, indicating significant improvement. The standard deviation rose from 2.23 to 4.01, reflecting a balanced performance gap among students. The N-Gain value of 0.44 categorized the media's effectiveness as moderate. Teacher responses rated the media at 85% (very practical), while student responses reached 80% (good).

The media is considered effective because it enhances students' mathematical representation skills and receives positive feedback from teachers and students. Finally, this study adds new information regarding mathematics education as reported elsewhere [33-36].

5. Conclusion

This study confirms that VBA-based digital learning media in Microsoft Excel effectively enhances elementary students' mathematical representation skills, particularly in fractions. The interactive features improve engagement and understanding, making abstract concepts more accessible. Pre- and post-test results show significant improvement, indicating moderate effectiveness. Teacher and student responses further validate its practicality. Integrating technology in mathematics education improves conceptual learning and problem-solving. This VBA-based media is a valuable innovation, with potential applications in broader mathematical concepts and future research in long-term learning outcomes.

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