

DIGITAL LEARNING MATHEMATIC MODULE WITH INTERACTIVE MULTIMEDIA IN INCLUSIVE SETTINGS

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Abstract

This study developed a digital mathematics learning module with interactive multimedia to support inclusive classroom settings. Using a mixed-method approach, data were collected from 25 teachers and learning assistants through questionnaires, interviews, and classroom observations. The findings indicated high usability and accessibility of the module, with most participants reporting improved student engagement, participation, and conceptual understanding in mathematics learning. Interactive features such as adjustable text, visual representations, and audio narration facilitated independent learning and reduced learning barriers for students with diverse needs. Observational and thematic analyses confirmed that the digital module enhanced instructional efficiency and supported differentiated instruction. Overall, the study demonstrates that digital mathematics modules are effective instructional tools for strengthening inclusive mathematics learning and promoting equitable participation in diverse educational environments.

Keywords: Digital book, Learning, Mathematics, Inclusive, Interactive multimedia.

1. Introduction

Digital learning resources are increasingly developed to support instructional practices in schools [1-6]. One of the difficult subjects is mathematics education [7-11]. In mathematics education, digital modules enable wider access to learning materials and assist teachers and learning facilitators in supporting students with diverse learning needs [12, 13]. In inclusive classrooms, the role of teachers and classroom assistants is essential, as they help students with disabilities participate in mathematical activities, follow instructions, and engage with problem-solving tasks.

However, many students with special needs face challenges in learning mathematics due to limited learning accommodations, accessibility barriers, and resource constraints [14]. Consequently, teachers and learning assistants may also experience difficulties when providing mathematics support in inclusive settings. Digital mathematics modules offer opportunities for educators to improve the accessibility of mathematical content [15]. Well-designed digital resources encourage active engagement, reduce learning barriers, and promote more independent participation for learners with different abilities [16, 17].

Visually Students with special needs often require specific instructional accommodations to participate effectively in mathematics learning. Digital mathematics modules allow teachers and classroom assistants to support learning more independently. Features such as adjustable font size, visual aids, step-by-step explanations, and embedded audio feedback make mathematical content more accessible for diverse learners. Technology-based instructional materials also enable students to review concepts at their own pace, improving comprehension and engagement during mathematics activities. Digital modules with captions, visual representations, and interactive elements can facilitate understanding of abstract mathematical ideas [18]. Enhancing control over the learning environment and fostering autonomy may contribute to students' confidence and achievement in mathematics. Digital learning resources can encourage students to explore content more willingly and actively participate during instruction.

Despite these potentials, research on digital mathematics learning for students in inclusive settings remains limited. Little is known about how digital mathematics modules support independent learning, engagement, and conceptual understanding among students with varied learning needs. Further investigation is necessary to determine how accessible digital materials enable learners to interact with mathematical representations, procedures, and problem-solving tasks. Issues related to digital resource quality and inclusive design also require examination.

Therefore, this study aims to develop a digital mathematics module as an instructional tool to support inclusive mathematics learning within school settings. The novelties of this study include: (i) interactive and accessible mathematics explanations designed for diverse learners, (ii) animated instructional content that simplifies abstract mathematical concepts, and (iii) portability and flexible use across learning situations.

2. Literature Review

Digital technology enables students and teachers to store, access, and interact with learning materials through compact digital devices that are significantly smaller than traditional textbooks [19]. Digital mathematics resources offer several

advantages: (i) electronic modules are easy to navigate and reuse, allowing mathematical content to be organized and accessed across different devices; (ii) no physical storage space is required for keeping mathematics materials; (iii) digital modules can be used both online and offline, increasing their flexibility during instruction; (iv) once developed, digital mathematics content can be distributed widely without additional printing or shipping costs; (v) digital modules promote environmentally friendly learning by reducing paper consumption; (vi) multimedia elements such as animations, simulations, and interactive tasks enrich mathematical explanations and make abstract concepts more engaging; and (vii) digital materials can be accessed anytime and anywhere, supporting continuous learning. Consequently, digital resources simplify access to mathematics content and facilitate more efficient and enjoyable learning experiences for diverse students.

3. Methodology

This study employed a mixed-methods approach combining quantitative and qualitative techniques to evaluate the use of a digital mathematics learning module in inclusive school settings. The participants consisted of 25 teachers and learning assistants from inclusive schools in several major cities in Indonesia, selected through purposive sampling. Data were collected using questionnaires to measure usability, accessibility, and perceived learning benefits, in-depth interviews to explore user experiences, and classroom observations to examine instructional practices. Quantitative data were analysed descriptively, while qualitative data from interviews and observations were examined using thematic analysis to identify recurring patterns related to accessibility, engagement, and learning support. Detailed information regarding this method is explained elsewhere [20].

4. Results and Discussion

Quantitative results showed that the digital mathematics modules were perceived as highly usable and beneficial. Approximately 85% of participants reported that the modules were easy to use, with an average usability score of 4.5 out of 5. More than 90% emphasized the importance of accessibility features such as adjustable text size, visual representations, and audio explanations, which received a satisfaction score of 4.7 out of 5. These features supported teachers and classroom assistants in facilitating mathematics instruction and managing diverse learner needs more effectively.

Participants also reported improvements in students' attention, engagement, and comprehension during mathematics lessons. Digital modules encouraged active participation and supported conceptual understanding, consistent with previous studies highlighting the role of digital tools in promoting engagement and active learning [21]. Classroom observations confirmed that digital modules improved instructional efficiency by enabling teachers to present mathematical concepts more clearly and allocate more time to students requiring additional support.

Visual aids, structured explanations, and audio narration helped students follow mathematical procedures and understand abstract concepts. Teachers and assistants observed increased student confidence and learning independence, particularly when students could control text size, visual pacing, and narration speed. Such flexibility allowed students to learn at their own pace and fostered greater

ownership of the learning process. These findings indicate that digital mathematics modules enhance participation and learning outcomes for students with special needs in inclusive settings [22]. The development and implementation of the digital module followed a structured instructional flow, as illustrated in Fig. 1.

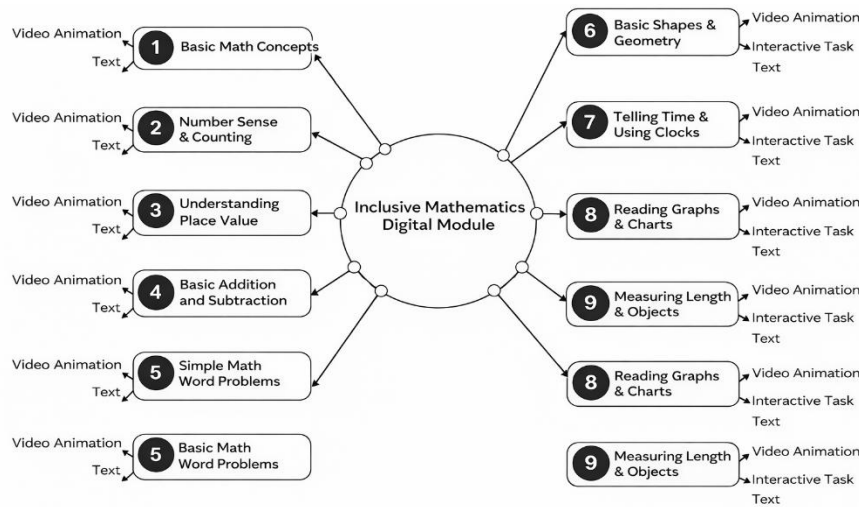


Fig. 1. Flowchart digital book.

Classroom observations further showed that digital mathematics modules increased student participation in inclusive classrooms. These findings align with previous research demonstrating that digital materials enhance engagement and function as effective instructional aids [23, 24]. The digital module incorporated structured explanations, interactive simulations, images, and text to support understanding across various introductory mathematics topics, including number concepts, basic operations, word problems, geometry, time, data interpretation, and measurement.

Thematic analysis revealed three key themes: accessibility, independence, and engagement. Teachers emphasized that digital modules reduced learning barriers for students with special needs and enabled independent review of mathematical content. Students could control learning features and interact with multimedia elements, supporting self-paced learning. Increased motivation and interest were also observed, as interactive features and clear explanations facilitated comprehension. These findings highlight the contribution of digital mathematics modules to improved access, engagement, and independent learning in inclusive classrooms [25-27].

Overall, the results demonstrate that digital mathematics modules enhance instructional efficiency and support inclusive mathematics education. Interactive and multimodal learning environments have been shown to improve mathematical performance [28]. Despite the need for continued attention to technological and pedagogical implementation, digital mathematics modules offer meaningful support for equitable participation and inclusive learning environments, contributing to broader efforts to improve inclusive education practices [29-37].

5. Conclusions

The findings indicate that digital mathematics learning modules effectively support inclusive mathematics education by enhancing accessibility, engagement, and learning independence for students with special needs. Interactive features such as audio narration, adjustable text size, and visual representations facilitated students' understanding of mathematical concepts and encouraged active participation. Teachers and learning assistants reported improved instructional efficiency, allowing greater focus on individualized support and conceptual guidance. These results demonstrate that digital mathematics modules can serve as effective instructional tools in inclusive classrooms, contributing to equitable learning opportunities and fostering more inclusive educational environments for students with diverse learning needs.

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