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Reimagining Geometry through *Matheor*: A Classroom-Based Study on Digital Engagement and Student Motivation

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ABSTRACT

This study aims to explore the effectiveness of the Matheor application as an innovative tool in increasing students' interest in learning mathematics, particularly geometry, at the junior high school level. This study was conducted using a mixed-method approach, which combines qualitative and quantitative data collection to provide a comprehensive understanding of students' learning experiences and their engagement. Quantitative data were obtained through a structured survey using a 5-point Likert scale, while qualitative data were collected through semi-structured interviews with 15 selected students from three junior high schools in Surabaya, Indonesia. The results showed that the Matheor application significantly increased students' interest and motivation in learning to understand two-dimensional and three-dimensional geometry concepts. Most students reported increased engagement and satisfaction with mathematics learning after using the application. Qualitative data analysis revealed that Matheor's interactive and visual features helped students better understand abstract concepts. Although some students experienced challenges in the initial use of the application, they generally felt more confident and motivated to learn. The discussion of the results shows that educational technology, when well designed, can change the way students interact with difficult subject matter, such as geometry. This study concludes that Matheor has great potential to be integrated into the mathematics curriculum, supporting national education goals in strengthening STEM education. However, further research with larger and more diverse samples is needed to

test the effectiveness of this application in various educational contexts.

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Keywords
Educational Technology
Junior High School
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Introduction

Mathematics is one of the fundamental disciplines essential for nurturing students' logical reasoning and analytical skills. Among its branches, geometry is a core component taught at the junior secondary school level, yet it is often perceived as complex and abstract due to the need for both strong conceptual understanding and visual-spatial reasoning. This perception frequently results in anxiety and disinterest among students, who tend to view mathematics as a difficult and intimidating subject [1]. However, learning interest is a critical determinant of academic achievement. When students are intrinsically motivated and perceive learning as enjoyable, they engage more deeply, retain knowledge better, and perform at higher academic levels [2]. The use of digital technology has a moderate positive effect on students' mathematics achievement, particularly for topics that require visualization and geometric concepts. Digital technology is more effective at increasing interest and understanding of visual concepts than abstract concepts [3].

Recent studies have emphasized the transformative potential of technology-enhanced and interactive learning approaches in mathematics education, particularly in fostering engagement and conceptual mastery in geometry [4], [5]. Then another researcher revealed that the development of AR educational games based on the Realistic Mathematics Education approach to improve the computational thinking of elementary school students in Malang is relevant to the context of visual and interactive mathematics education at the primary and secondary education levels [6]. Applications such as GeoGebra and Desmos have enabled students to explore mathematical concepts interactively and independently. However, existing literature lacks sufficient exploration of augmented reality (AR) and gamified tools in the specific context of lower secondary geometry education in Indonesia—a gap that underscores the need for culturally responsive, engaging, and scalable innovations. Prior research confirms that interactive technologies can enhance spatial visualization and support the comprehension of complex geometric structures [7], [8], but localized implementation strategies remain underdeveloped.

To address this gap, Matheor's geometry learning program offers augmented reality (AR)-based innovations specifically designed for junior high school environments in Indonesia. By combining geometric elements from flat and three-dimensional shapes, Matheor not only increases student participation through interactive methods but also strengthens their understanding of geometric concepts through more in-depth visual and kinesthetic experiences. Through its 2D-based AR features, spatial visualization skills, which are often a barrier to learning geometry, are further strengthened. Matheor encourages students to learn independently and compete in a fun and measurable environment. This method fills a gap in the literature by offering new solutions tailored to local needs, while also supporting the development of critical and creative thinking skills in mathematics. The use of AR provides a practical and concrete learning experience [9]. Then the opinion [10] that Developing a mathematics-based AR application to improve understanding of basic mathematical concepts, especially geometry, with significant results in improving students' pre-test and post-test scores, especially for junior high school level. The application delivers content through text, images, animation, and special effects, responding to empirical evidence that students are more engaged when learning through digital platforms [11]. According to [12] "one method of applying behavioral analysis to change behavior is to emphasize the behavior that students want to do, rather than the behavior they want to avoid. " This is in line with the view that mathematics learning is a process of interaction between teachers and students that involves patterns of thinking and logical processing in a learning environment created or desired by teachers through various approaches so that mathematics learning programs can develop and function optimally and Sweller's Cognitive Load Theory, which advocates for instructional designs that reduce extraneous load and enhance conceptual clarity [13].

This study aims to evaluate the effectiveness of the Matheor application in increasing students' interest in learning geometry at the junior secondary level. Using a mixed-methods approach, Mixed-method research gives researchers the freedom to determine data collection methods, and when results are presented by combining numerical summaries and in-depth analysis of a context, they are more convincing and robust. Measurements are taken using quantitative methods and qualitative data is collected directly in the field. This data collection technique includes distributing questionnaires and conducting interviews with junior high school students living in the city of Surabaya [14]. Yanuarto [15] examined the application of AR in mathematics learning and showed a significant increase in students' understanding of geometric concepts and motivation to learn with AR-based learning media.

By bridging theory and practice, the research offers practical insights into how localized digital tools can enrich classroom instruction and support national educational goals

in STEM. AR-based learning media for spatial concepts in mathematics that integrates the STEAM and Project Based Learning approaches. The results show the effectiveness of AR media in improving student learning outcomes and spatial understanding, which is considered interesting and can significantly increase student engagement [16]. Based on the theoretical and empirical background discussed above, this study seeks to answer the following research question: To what extent is the Matheor application effective in increasing junior high school students' interest in learning mathematics, particularly in understanding the concepts of two-dimensional and three-dimensional geometry?

Material and Methods

This study aims to explore the effectiveness of the Matheor application as an innovative digital tool to enhance students' interest in learning mathematics, particularly in the field of geometry. A mixed-methods approach was employed, combining qualitative and quantitative methodologies to provide a comprehensive understanding of students' learning experiences and engagement [17].

A. Research Design

The study adopted an exploratory-descriptive research design integrating both qualitative and quantitative data collection. The qualitative component focused on exploring students' perceptions and experiences in depth, while the quantitative component measured the level of engagement, satisfaction, and interest in geometry through structured surveys. This design allowed for triangulation of data to strengthen the validity of the findings [23].

B. Research Context and Participants

Population is a generalization area consisting of objects/subjects that have certain qualities and characteristics determined by researchers to be studied and then conclusions drawn [18]. The research was conducted in three public junior high schools (*Sekolah Menengah Pertama Negeri*) located in Surabaya, Indonesia, selected purposively based on their willingness to integrate digital technology into the classroom and the availability of infrastructure to support the use of mobile learning applications.

The study involved 60 eighth-grade students (aged 13–14), who were asked to use the *Matheor* application over a two-week period as part of their regular mathematics instruction. Participants included both male and female students, with a roughly equal gender distribution. All students had basic digital literacy and access to smartphones or school-provided tablets. The use of *Matheor* focused specifically on geometry topics such as two-dimensional (2D) and three-dimensional (3D) shapes.

C. Sampling and Selection for Interviews

Purposive sampling, also known as judgmental, selective, or subjective sampling, reflects a group of sampling techniques that rely on the researcher's judgment when it comes to selecting

units (e.g., people, cases/organizations, events, data pieces) to be studied [19]. One of these purposive sampling techniques is maximum variation sampling. The maximum variation sampling method is used to select some individuals from the population to be studied, so that the data obtained can represent the conditions of the population as a whole [20].

Following the intervention period, a sample of 15 students was selected for semi-structured interviews**.** The selection used maximum variation sampling, ensuring diversity in gender, initial mathematics performance (based on teacher input), and frequency of app usage. The goal was to capture a wide range of perspectives on how different students interacted with and benefited from the application.

D. Instruments and Data Collection

The instruments consisted of two main tools: an interview guide for qualitative data collection and a structured questionnaire for quantitative measurement. The questionnaire items included indicators such as classroom engagement, ease of use, perceived usefulness, and motivation toward learning geometry through the Matheor application [22]**.**

In qualitative research, an instrument is an interview guide containing a list of questions or topics to be discussed in a qualitative interview [21]. The interview guide provides a framework for researchers to ask relevant and in-depth questions to research participants. The interview guide may also contain sample questions that can be used as a guide for researchers.

The data collection technique used in qualitative research is interviewing, which is a data collection technique that involves direct interaction between the researcher and the research participants [22]. Qualitative interviews aim to gain an in-depth understanding of the experiences, views, and perspectives of individuals related to the phenomenon being studied. Interviews can be conducted in a structured, semi-structured, or unstructured manner, depending on the level of framework that has been determined beforehand [23].

This study focuses on how students use applications to solve mathematical problems, as well as their level of involvement and participation in the learning process [24]. During the study, students interacted with the Matheor application as part of their regularly scheduled mathematics classes under the guidance of their teachers. The app offered a variety of features, including visual explanations of geometric concepts, interactive puzzles, multiple-choice quizzes, and augmented reality tools that allowed users to manipulate three-dimensional objects. This integration aimed to create a dynamic and engaging learning environment that could support both visual and kinesthetic learning styles. The use of learning models that encourage students to actively participate in learning, such as problem-based learning models, can help students develop good mathematical critical thinking skills [25].

To gain deeper insights into the user experience, semi-structured interviews were conducted individually with 15 selected students. Each interview lasted approximately 20 to 30 minutes and followed a flexible protocol, enabling researchers to delve into students' perceptions of the application, their evolving interest in mathematics, and how Matheor influenced their understanding of two-dimensional and three-dimensional geometry. These interviews provided rich qualitative data that captured students' reflections on both the educational and motivational aspects of the digital tool.

In addition to interviews, all 60 participating students completed a post-intervention structured survey to capture broader patterns of engagement and satisfaction. The survey utilized a 5-point Likert scale to assess variables such as perceived classroom engagement (e.g., "I felt more engaged in class using Matheor"), satisfaction with the application (e.g., "I found the app helpful in understanding shapes"), and self-reported interest in geometry (e.g., "I became more interested in learning geometry"). These quantitative responses complemented the interview findings and offered valuable metrics for evaluating the effectiveness of Matheor in the classroom setting.

The combination of these methods enabled the researchers to capture both measurable outcomes and rich contextual insights regarding students' learning experiences [17].

E. Data Analysis

1. Qualitative Analysis: interview transcripts were analyzed using thematic analysis. Initial open coding identified recurring patterns related to conceptual understanding, learning motivation, and user experience. Themes were then refined collaboratively among researchers to ensure inter-rater reliability and minimize bias.
2. Quantitative Analysis: survey data were analyzed using descriptive statistics, including mean scores, percentages, and frequency distributions, to illustrate overall trends in students' engagement and satisfaction.

Qualitative data from the student interviews were transcribed verbatim and analyzed through a rigorous thematic analysis approach. The analytical process began with initial open coding of the transcripts to identify recurring ideas, phrases, and emotional responses expressed by participants. This step allowed researchers to capture nuanced insights into how students experienced and interpreted their interactions with the Matheor application [26].

The codes were then organized into broader categories reflecting key aspects of the learning experience, such as *visual engagement*, *conceptual clarity*, and *learning motivation* [27]. Within these categories, recurring patterns led to the development of themes and subthemes—such as *confidence in problem-solving*, *enjoyment of digital tools*, and *increased attention during math lessons* [28]. These themes highlighted how Matheor influenced students' cognitive and affective engagement with geometry.

To ensure consistency and credibility, multiple researchers independently reviewed and refined the emerging themes through collaborative discussions [29]. This process enhanced inter-rater reliability and helped reduce individual bias in interpretation. The final thematic map was used to structure the qualitative findings, offering a rich, in-depth understanding of students' perceptions and the pedagogical impact of the Matheor application.

Quantitative survey data were analyzed using descriptive statistics to identify patterns in student engagement and satisfaction after using the Matheor application. Key metrics included mean scores, frequency distributions, and percentage changes across Likert-scale responses. These descriptive insights provided a clear snapshot of students' attitudes toward geometry learning in a digital context [30].

Although no inferential statistical tests were conducted—given the study's exploratory design and relatively small sample size—the survey data effectively complemented the qualitative findings. By triangulating with the thematic analysis from interviews, the quantitative results reinforced the observed increase in motivation and conceptual understanding [31]. Together, these datasets offered a well-rounded perspective on the feasibility and perceived effectiveness of Matheor as a digital learning tool in middle school geometry education. Finally, both qualitative and quantitative findings were triangulated to provide a holistic understanding of the effectiveness of Matheor in enhancing students' interest and motivation in learning geometry [17].

F. Ethical Considerations

Prior to data collection, ethical approval was obtained from the Ethics Committee of Universitas Negeri Surabaya. Participation was voluntary, and informed consent was secured from both students and their parents or guardians. All data were anonymized to protect the identity of participants, and care was taken to maintain confidentiality throughout the research process [32].

Results and Discussions

A. Overview of Findings

Survey data gathered from 60 junior high school students and interviews with 15 selected participants indicate that the *Matheor* application positively influenced students' interest and motivation in learning mathematics—particularly in the domain of geometry. A majority of students reported that they found learning about two-dimensional and three-dimensional shapes more engaging and accessible after using the application.

B. Quantitative Feedback Summary

To capture broader patterns of engagement and satisfaction, students completed a post-usage survey using a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree."

This instrument was designed to assess key aspects such as ease of use, enjoyment, perceived usefulness, and motivation to continue learning mathematics through the Matheor application. The survey provided a structured method to quantify students' experiences and attitudes following their interaction with the app. Table 1 summarizes the core indicators derived from this survey, offering insight into how students perceived the application's usability and its effectiveness in enhancing their understanding and interest in geometry.

Table 1. Student Feedback Summary on Matheor Usage

Indicator	Mean Score	Standard Deviation	% Agree/Strongly Agree
Increased interest in geometry	4.2	0.54	87%
Ease of use of Matheor	3.9	0.71	76%
Enjoyment of visual learning tools	4.4	0.48	91%
Motivation to study more mathematics	4.1	0.67	83%
Would recommend to peers	4.3	0.60	85%

These quantitative results confirm that students experienced a substantial shift in both engagement and affective orientation toward mathematics. The increase in students' interest, particularly in the domain of geometry, demonstrates the capacity of the *Matheor* application to transform mathematics learning from a traditionally abstract subject into an interactive and visually intuitive experience. This shift is particularly significant in early secondary education, where students often struggle to connect theoretical content with real-world application. The data reveals that features such as visual representation, gamified tasks, and user-friendly navigation contributed to students' enjoyment and motivation, reinforcing the idea that digital learning tools can play a pivotal role in reducing math anxiety and increasing student confidence.

Moreover, the observed affective gains suggest that students began to develop more positive attitudes toward mathematics after the intervention. Many students reported feeling more capable and less intimidated by geometric problems, attributing their progress to the clarity and accessibility provided by *Matheor*. This points to a broader implication: educational technologies, when designed with pedagogical sensitivity, can reshape students' perceptions of challenging subjects and foster long-term academic resilience. However, to ensure these benefits are sustainable and inclusive, educational stakeholders must address potential barriers such as unequal access to devices, varying levels of digital literacy, and the need for teacher facilitation. Ultimately, the results support the argument that technology-enhanced interventions like *Matheor* hold great promise, provided they are integrated thoughtfully into the learning environment.

C. Qualitative Insights from Student Interviews

Thematic analysis of the interview transcripts revealed three dominants' themes.

1. Improved Conceptual Understanding

Students reported that the visual and interactive features of the Matheor application, particularly the augmented reality (AR)-based geometry demonstrations, greatly enhanced their conceptual understanding. They emphasized that these dynamic visualizations allowed them to "see" and manipulate geometric shapes in ways traditional textbooks could not provide. This experiential, hands-on interaction helped bridge abstract concepts with concrete visualization, making it easier for students to grasp spatial relationships and geometric properties. Such feedback highlights the unique advantage of integrating AR technology into mathematics instruction to support deeper, more intuitive learning.

2. Learning Enjoyment

Many students described the app as "fun" and "different" compared to traditional classroom instruction, highlighting the novelty and engagement it brought to their learning experience. One student notably stated, "I finally understand volume after seeing it move in 3D" [33], underscoring the powerful role of dynamic visual aids in making abstract mathematical concepts more accessible. Such testimonials suggest that Matheor's interactive features not only enhance enjoyment but also foster meaningful cognitive breakthroughs, particularly in areas like geometry that benefit from spatial visualization.

3. Initial Usability Challenges

Several students admitted experiencing difficulties navigating the app during their initial session, indicating that while Matheor offers intuitive features, a learning curve still exists for new users. This feedback underscores the importance of integrating onboarding tutorials or providing in-class guidance to ensure smooth adoption, particularly for students who may have limited experience with digital learning tools. Implementing these support mechanisms could enhance user confidence and maximize the application's educational impact from the outset.

D. Matheor UI Visuals and Engagement Snapshots

Visual data in the form of UI screenshots [34] depict the interactive homepage**,** geometry object explorer, and tangram mini-games. These visuals illustrate how users interact with geometry concepts in real-time and gamified environments. A chart comparing pre- and post-intervention self-reported interest levels is provided in Figure 1, supporting the upward trend in engagement post-Matheor exposure.

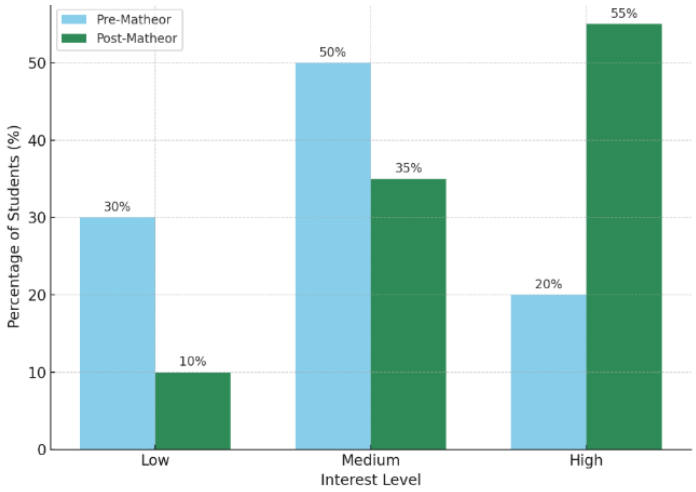

Fig. 1. Student Interest Levels in Geometry: Pre-Matheor and Post-Matheor

Fig. 1 illustrates the impact of the Matheor application on students' interest levels in learning geometry. Prior to using the application, student interest was distributed with 30% reporting low interest, 50% moderate interest, and only 20% indicating high interest. These figures reflect the common challenge of engaging junior high school students in abstract mathematical content, particularly in topics such as two-dimensional and three-dimensional geometry.

Following the implementation of Matheor in classroom settings, a notable shift was observed. The proportion of students with low interest dropped significantly from 30% to 10%, while those with moderate interest decreased slightly from 50% to 35%. Most importantly, students who reported high interest in geometry more than doubled, rising sharply from 20% to 55%. This shift indicates a substantial improvement in affective engagement and curiosity toward mathematical content.

These results strongly suggest that the interactive and visual learning experience provided by Matheor plays a critical role in reshaping students' attitudes toward geometry. The increased level of high interest reflects the application's success in not only making geometry more approachable but also more enjoyable. Therefore, digital tools like Matheor may serve as an effective intervention strategy to boost motivation in subjects traditionally perceived as difficult or uninteresting.

This visualization reinforces the earlier qualitative findings, confirming that Matheor effectively enhances student engagement in geometry learning. The substantial shift from lower to higher interest levels demonstrates the application's ability to transform students' attitudes toward mathematics by making abstract concepts more tangible and interactive. By bridging the gap between content delivery and student motivation, Matheor emerges as a valuable educational tool capable of addressing one of the most persistent challenges in mathematics instruction: fostering sustained interest and enthusiasm among learners.

E. Critical Analysis and Contextualization

While the data affirms Matheor's effectiveness in enhancing student motivation and conceptual understanding in geometry, several limitations must be carefully considered to contextualize the findings. First, the sample size presents a constraint on the generalizability of the results. Although 60 students completed the survey and 15 participated in interviews, this group may not adequately represent the broader diversity of students across different regions, socio-economic backgrounds, or school systems. Future research should aim to include larger and more varied samples to capture a more comprehensive range of experiences and learning outcomes.

Second, the reliance on self-reported data introduces the possibility of bias. Students' responses in surveys and interviews may have been influenced by social desirability or memory recall limitations rather than accurately reflecting measurable learning improvements. While students reported increased interest and motivation, these perceptions should be validated through objective indicators, such as pre-intervention and post-intervention test scores, offering a more reliable gauge of academic impact.

Third, access inequality remains a critical issue. Echoing previous research by Fuchs (2020) and [36], some students encountered difficulties related to limited access to digital devices, poor internet connectivity, or discomfort in using educational technology. Then, according to [37], analysis of the role of technology in mathematics learning shows obstacles such as limited internet access, power outages, and a lack of appropriate training for teachers. They emphasize the need for synergy between teachers and students and the provision of appropriate training so that technology can be applied effectively. Other studies also confirm that infrastructure limitations and digital literacy are major obstacles to the implementation of educational technology in Indonesia, requiring comprehensive and sustainable policy support to bridge this digital divide [38]. These disparities can contribute to uneven learning experiences and risk deepening existing educational gaps if not adequately mitigated through infrastructure support and inclusive policy planning.

Finally, several students experienced initial usability challenges, underscoring the need for adequate training and technological readiness. This observation aligns with [39], who highlight that successful digital transitions depend not only on tool availability but also on user competence and institutional preparedness. Therefore, to maximize the effectiveness of Matheor and similar digital platforms, it is essential to provide structured onboarding tutorials, teacher training, and ongoing technical support, ensuring that both educators and learners can fully benefit from the innovation.

F. Positioning Within the Literature

The results support prior literature indicating that interactive educational technologies, when implemented thoughtfully, can promote deeper understanding and motivation in STEM subjects [40], [41]. Matheor's ability to translate abstract geometric concepts into visual and manipulable learning experiences directly addresses long-standing pedagogical challenges in mathematics education, particularly within the domain of geometry. By enabling students to engage with shapes dynamically, the application supports both conceptual clarity and increased learner engagement, reinforcing the cognitive benefits of visual-spatial reasoning tools.

What distinguishes this study is its contextual specificity and technological innovation. Unlike previous research conducted predominantly in Western or resource-rich educational environments, this study explores the integration of augmented reality (AR) features in a culturally responsive application designed for middle school students in a Southeast Asian, specifically Indonesian, context. This regional focus offers valuable insight into how digital tools can be adapted to local curricula, language, and learning norms—an area still underrepresented in the global educational technology discourse.

As digital transformation gains momentum across Indonesian classrooms, the findings presented here provide practical implications for both policymakers and practitioners. The success of Matheor illustrates the potential of student-centered, locally developed innovations to bridge the gap between curriculum demands and learner needs. With appropriate infrastructure, training, and support systems, such innovations can be scaled more broadly to support national educational goals, particularly in improving STEM competencies and reducing urban-rural digital divides.

Conclusion and Implications

The findings of this study highlight the potential of *Matheor* as an innovative digital tool for enhancing students' interest and confidence in learning mathematics, particularly in understanding geometric concepts. By providing interactive visualizations and adaptive practice exercises, *Matheor* successfully engages students in ways that traditional instruction often cannot. The majority of student participants reported increased motivation and a deeper conceptual grasp of two-dimensional and three-dimensional geometry after using the application, suggesting its effectiveness in transforming abstract content into accessible and enjoyable learning experiences.

Nevertheless, the successful implementation of *Matheor* in school settings requires more than technological innovation alone. Critical factors such as teacher facilitation, technological infrastructure, and equitable student access must be addressed to ensure that its benefits are realized across diverse educational contexts. While most students adapted well to

the application, initial usability challenges indicate the need for user onboarding features or instructional support within the application interface.

Importantly, this study also highlights the limitations of short-term interventions and self-reported feedback. Furthermore, respondent feedback may be subject to subjective bias, which could further influence the outcome characteristics. Therefore, the findings need to be interpreted and validated with more objective follow-up research. To strengthen the evidence base, future research should adopt a longitudinal design, incorporate objective measures of academic performance, and examine teachers' perspectives on pedagogical dissemination. Furthermore, the limited sample size within a single geographic region may limit the generalizability of the findings. Therefore, a larger sample size is needed to broaden the scope by incorporating diverse educational levels and demographic contexts to provide a more comprehensive picture of the application's scalability and adaptability.

In conclusion, *Matheor* demonstrates considerable promise as a technology-enhanced learning solution capable of increasing student engagement and understanding in mathematics. With strategic development and systemic support, the application could play a vital role in modernizing geometry instruction and promoting sustained mathematical interest among students. Its integration into broader STEM education efforts reflects a meaningful step toward more equitable and engaging digital learning environments.

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Conflict of Interest

The authors declare no conflict of interest.

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