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Design and Development of Construct 2-Based Learning Media for Teaching Three-Dimensional Geometry

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ABSTRACT

Game-based learning environments, in particular, offer enjoyable learning experiences while supporting the development of conceptual understanding. This study aims to develop and evaluate Construct 2–based learning media for teaching three-dimensional geometry in Grade 7. The research employed a Research and Development (R&D) design using the Akker model. Participants included media experts, material experts, and seventh-grade students from a public junior high school in Manado. The instruments used comprised expert validation sheets, student practicality questionnaires, and learning achievement tests. The development procedure involved identifying learning challenges related to students' difficulties in visualizing geometric solids, designing the Construct 2 media, conducting expert validation, implementing one-to-one and small-group evaluations, and conducting a classroom field test. Data were analyzed descriptively to assess the validity, practicality, and effectiveness of the developed media. The findings indicate that the learning media achieved high validity based on evaluations from both media and material experts, high practicality based on students' responses, and high effectiveness based on learning outcomes. The dynamic visualizations, interactive quizzes, and mobile accessibility offered by the media helped students overcome common difficulties in distinguishing and visualizing geometric solids and their nets. The novelty of this study lies in demonstrating the pedagogical value of Construct 2 not only as a feasible development tool but also as an effective instructional intervention. The study offers practical implications for educators seeking effective digital media for geometry instruction and provides a foundation for further innovation in game-based mathematics learning.

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Introduction

Mathematics is taught at all levels of education because it serves as the foundation of knowledge across fields, including technology and daily life (Freeman et al., 2020; Psycharis & Kalogeria, 2018; Zambak & Tyminski, 2020). According to the Kerangka Dasar dan Struktur Kurikulum, the goals of mathematics education are to develop students' cognitive abilities, particularly higher-order thinking skills, to build students' capacity to solve problems effectively, and to train them to communicate mathematical concepts clearly (Utari & Hartono, 2019). With the rapid advancement of digital technologies, educators are expected to leverage these developments to support the improvement of students' cognitive skills (Yilmaz, 2020). This research responds to these demands by introducing a technology-enhanced learning medium that integrates interactive and game-based features to support conceptual understanding.

In this era of digital transformation, technology is advancing at an extraordinary pace, including in the education sector (Remillard et al., 2021). Technological developments have resulted in numerous innovations that support the learning process. Learning, which was once limited to teachers, textbooks, and classroom activities, can now be accessed through the internet and various electronic media (Dreyfus, 2018; Hajeniati & Kaharuddin, 2022; Velani & Retnawati, 2020). With easily accessible internet and digital devices, students can learn anytime and anywhere without direct guidance from a teacher. These shifts highlight the need for instructional tools that align with students' learning habits, particularly tools that enable flexible, mobile, and autonomous learning.

One form of technological advancement in education is the emergence of mobile learning (m-learning) (Kurniasih et al., 2020). Learning activities that were previously conducted only face-to-face in schools can now take place online or remotely. The m-learning concept utilizes mobile devices such as smartphones, laptops, tablets, and PCs to bridge technology with education. These technological developments are expected to enhance learning and offer solutions to challenges faced by teachers and students, particularly in improving students' mathematical abilities (Hsieh et al., 2025; Utami et al., 2018; Zambak & Tyminski, 2020). However, despite these advancements, the integration of mobile-based game elements into mathematics learning (especially for three-dimensional geometry) remains limited, which forms one of the core novelties of this study.

A study by Domu & Mangelep (2019) on "Developing Mathematics Learning Tools Based on Bolaang Mongdow Local Wisdom for Elementary Schools" showed that students often experience confusion when visualizing concepts, principles, procedures, and problem solving described verbally during mathematics lessons. One of the main challenges students face in solving mathematical problems is difficulty understanding and applying fundamental principles. This occurs because students often do not fully grasp the material during instruction, learning media are limited, teaching methods remain teacher-centered, engaging practice problems are lacking, and technology that supports students' visualization and conceptual understanding is underutilized. The present study specifically addresses these gaps by developing a digital, interactive medium capable of improving students' conceptual visualization and engagement.

Based on these findings, teachers must innovate by developing learning media that help students better understand mathematical concepts, principles, and skills while aligning with their learning needs. As educators, we must create learning experiences that are enjoyable for students so they become more motivated to learn (Hamami & Morris, 2020; Jankvist et al., 2020). One way to achieve this is through the development of instructional media that incorporate game elements. A game is a form of play activity in which players attempt to achieve specific objectives by acting according to predefined rules (Kärki et al., 2022; Nisa &

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Susanto, 2022). By combining game mechanics with instructional content, this research introduces an approach that transforms students' gaming habits into productive learning behaviors, which is a key novelty distinguishing this study from previous work.

Observations conducted during the Kampus Mengajar 5 program in the 2022/2023 academic year at SD Inpres Pinaras revealed that many students were addicted to playing games, which reduced their willingness to learn. Therefore, designing instructional media that incorporate games can be a potential solution for increasing students' interest in learning and transforming their gaming habits into a productive learning tool. In instructional media development, games can function as quizzes or evaluation tools for teachers. Besides fostering learning interest, educational games can also train students' concentration, sportsmanship, and problem-solving skills. The integration of Construct 2 within this context offers a practical pathway for both motivation and diagnostic assessment, aligning technological tools with pedagogical needs.

Interviews with a mathematics teacher at SMP Negeri 4 Manado in the 2023/2024 academic year revealed that students experienced difficulties in learning three-dimensional geometry. They struggled to distinguish between types of 3D shapes (triangular prisms, cylinders, square pyramids, cones, and spheres) and to visualize 3D objects from their nets. Learning media were also still underdeveloped (Hong & Choi, 2011; Lichti & Roth, 2019; Swidan et al., 2020). Most teachers relied solely on PowerPoint and had never used game-based instructional media. Students also found it difficult to access learning materials outside of class hours because the media were only provided during lessons. These conditions reinforce the relevance and urgency of developing mobile–game-based learning media that not only support visual understanding but also remain accessible beyond classroom boundaries.

With the advancement of technology, educators must continue to innovate in developing learning media. One promising solution is the development of instructional media using Construct 2 software. Construct 2 is an HTML5-based game-development tool designed for 2D platforms and developed by Scirra. This software is appealing because it does not require special programming languages; all commands are arranged in the EventSheet, which consists of Events and Actions. Furthermore, the resulting instructional media can be installed on students' smartphones or other mobile devices, allowing students to access learning anytime and anywhere. This study leverages Construct 2 to create a practical, accessible, and interactive learning medium, marking a methodological novelty in the context of mathematics education at the junior secondary level. For these reasons, the researcher is interested in conducting a study entitled "Development of Learning Media Using Construct 2 Software for Grade 7 Three-Dimensional Geometry." The overarching purpose of this research is to design, develop, and implement a mobile-accessible, game-based instructional medium that enhances students' conceptual understanding of three-dimensional geometry, increases learning motivation, and provides teachers with an innovative evaluation tool. The expected implications include improved visualization skills, higher student engagement, and a scalable technological model that can be adapted to other mathematical topics and learning environments.

Method

Type of Research

This research employed a Research and Development (R&D) design, with the primary outcome being the creation of a game-based learning medium developed using Construct 2 software for the Grade 7 topic of three-dimensional geometry. The study was conducted at SMP

Negeri 4 Manado, where preliminary investigations revealed several instructional issues, including limited learning media, difficulties in visualizing geometric objects, and challenges in distinguishing different types of solid figures. These contextual problems served as the foundation for the preliminary research stage as outlined in Akker's development model, which consists of three phases: preliminary research, prototyping, and summative evaluation (Ratnayake et al., 2020).

Participants

The development process involved several groups of participants across multiple formative evaluation stages. In the one-to-one evaluation stage, three students representing low, medium, and high academic abilities participated to provide initial feedback on usability and comprehension. The small-group evaluation involved six students to assess interaction patterns and media operability in a collaborative setting. The field test, conducted during the final stage of formative evaluation, included 25 Grade 7 students (class VII-1), allowing the researchers to observe the effectiveness of the media in a real classroom environment. In addition, the validation phase included two media experts and one subject-matter expert who evaluated the content accuracy, design quality, and overall coherence of the developed product.

Instruments and Procedures

The research development cycle consisting of preliminary research, prototyping, and summative evaluation. The preliminary research involved a literature review and needs analysis to identify key obstacles in mathematics learning at SMP Negeri 4 Manado. The prototyping stage began with the selection of Construct 2 as the software platform for game-based media development, followed by the design of the layout and EventSheet structure, which governs the logical flow through Events and Actions. The formative evaluation consisted of expert review, one-to-one evaluation, small-group evaluation, and field testing. Expert review involved assessing the validity of the media content, interface, navigation, and instructional accuracy. Subsequent one-to-one and small-group evaluations focused on practicality and usability from the students' perspective. Field testing examined how students interacted with the finalized prototype in actual learning conditions. Summative evaluation was conducted to measure both the effectiveness and practicality of the media. Effectiveness was assessed through a student learning achievement test, whereas practicality was measured by student response questionnaires.

Analysis

The analysis consisted of three components: validity analysis, practicality analysis, and effectiveness analysis. Each component used specific scoring procedures and interpretation criteria to determine whether the Construct 2–based learning media met the required quality standards for instructional use. Validity analysis was conducted using expert appraisal from two media experts and one subject-matter expert. All experts assessed the media using standardized evaluation rubrics. Their scores were converted into percentage values and classified according to validity criteria. The media was considered valid if it achieved at least the "Valid" category.

Table 1. Validity Scoring Criteria

Percentage Range	Interpretation
85% – 100%	Highly Valid
70% – 85%	Valid
55% – 70%	Fairly Valid
40% – 55%	Less Valid

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0% – 40%	Not Valid

Construct 2–based learning media is considered valid if the percentage score is ≥ 70%.

Practicality analysis used student response questionnaires collected during the formative testing stages. Students rated clarity, usability, accessibility, and engagement. The resulting data were classified using practicality criteria (Horbi, 2010). The media was considered practical if it reached at least the "Practical" category.

Table 2. Practicality Scoring Criteria

Percentage Range	Interpretation
85% – 100%	Highly Practical
70% – 85%	Practical
55% – 70%	Fairly Practical
40% – 55%	Less Practical
0% – 40%	Not Practical

The media is considered practical if the percentage score is ≥ 70%.

Effectiveness analysis measured the extent to which the learning media improved students' mastery of the material. The percentage of students achieving mastery on the learning outcome test was calculated and evaluated using effectiveness criteria from Akbar (2013). The media was deemed effective if it attained at least the "Effective" category.

Table 3. Effectiveness Scoring Criteria

Percentage Range	Interpretation
80% – 100%	Highly Effective
60% – 80%	Effective
40% – 60%	Fairly Effective
20% – 40%	Less Effective
0% – 20%	Not Effective

The media is considered effective if the student mastery rate is ≥ 60%.

Results

The results of this study consist of a learning media product in the form of an application and an HTML5 package that incorporates game elements as an evaluation tool for the topic of three-dimensional geometry. The research adopted the AKKER (2006) development model, which includes three stages: preliminary research, prototyping, and summative evaluation.

Preliminary Research

During the preliminary stage, interviews and classroom observations were carried out to identify learning problems at SMP Negeri 4 Manado. The interview with a mathematics teacher revealed that students faced significant learning difficulties, especially in distinguishing between types of three-dimensional shapes (triangular prisms, cylinders, square pyramids, cones, and spheres) and in visualizing solid figures from their nets. Instructional media were rarely used, and teaching remained largely teacher-centered, relying primarily on printed textbooks. These findings indicated a critical need for interactive and engaging learning tools. Thus, the researcher selected game-based learning media as a pedagogical response to overcome the visualization and engagement problems observed during instruction. These initial findings align strongly with documented challenges in geometry learning, particularly regarding spatial visualization deficits. The absence of interactive media contributed directly to

students' conceptual difficulties. The decision to adopt game-based mobile learning media therefore responds directly to these contextual needs and establishes the relevance of the innovation.

Prototyping Stage

This stage consisted of software selection, media design, and formative evaluation. Construct 2 was chosen due to its ability to produce mobile-friendly games and applications without requiring advanced programming skills. All logical commands were organized using the EventSheet structure, composed of Events and Actions. The completed game could be installed on smartphones and other mobile devices. The media were then designed using Construct 2, as shown in Figure 1.

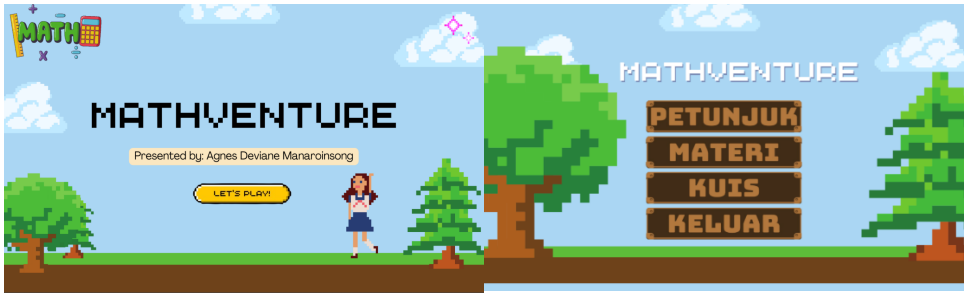

Figure 1. Prototype Layout of the Learning Media

After the design phase, the media underwent formative evaluation consisting of expert review, one-to-one evaluation, small-group evaluation, several revision cycles, and field testing. This process ensured iterative refinement of the learning media.

Media Expert Review

Media validation was carried out by two specialists in Mathematics Education from Manado State University, whose evaluations focused on the technical, visual, and pedagogical quality of the learning media. The detailed scores are presented in Table 4.

Table 4. Media Expert Review Results

Validator	Score
Derel F. Kaunang, S.Pd., M.Pd	93
Marvel G. Maukar, S.Pd., M.Pd	96
Average	**94.5**

The combined average score of 94.5% places the media within the "Highly Valid" category. This indicates that the interface layout, navigation flow, color composition, typography, and responsiveness across devices meet professional standards for interactive learning environments. The experts also noted that the integration of game mechanics was executed consistently and functionally, enhancing the instructional value of the media without compromising usability. The high rating affirms that the media design aligns well with cognitive and motivational principles relevant to middle-school learners.

Material Expert Review

The material expert evaluation was conducted by a mathematics teacher from SMP Negeri 4 Manado, who assessed content accuracy, curriculum alignment, conceptual clarity, and the suitability of exercises embedded in the game. The results are presented in Table 5.

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Table 5. Material Expert Review Results

Validator	Score
Carolina Ch Thenu, S.Pd	94.55

The score of 94.5% classifies the learning media as "Highly Valid" from a content perspective. This implies that the mathematical concepts, representations of three-dimensional figures, and problem-solving tasks are accurate, grade-appropriate, and consistent with curriculum requirements. The expert also confirmed that the learning sequence embedded in the game supports progressive conceptual understanding, enabling students to connect visual representations with formal properties of 3D objects.

The consistently high validity scores across both media and material evaluations indicate that the developed product is pedagogically robust and technically coherent. The alignment of design features with curriculum standards demonstrates that Construct 2 provides an effective platform for translating abstract geometric concepts into interactive experiences that are more accessible to students. These findings validate the decision made during preliminary research to adopt a game-based approach, as the resulting media successfully address the key conceptual and motivational challenges initially identified in the classroom setting. The expert reviews also highlight the strong potential of the media to support visualization, engagement, and independent learning, three elements that are crucial in improving performance in three-dimensional geometry. The consistently high validity scores across both media and material evaluations indicate that the developed product is pedagogically robust and technically coherent. The alignment of design features with curriculum standards demonstrates that Construct 2 provides an effective platform for translating abstract geometric concepts into interactive experiences that are more accessible to students. These findings validate the decision made during preliminary research to adopt a game-based approach, as the resulting media successfully address the key conceptual and motivational challenges initially identified in the classroom setting. The expert reviews also highlight the strong potential of the media to support visualization, engagement, and independent learning, three elements that are crucial in improving performance in three-dimensional geometry.

One-to-One Evaluation

The one-to-one evaluation involved three students representing high, medium, and low mathematical abilities. This stage served as an initial usability test aimed at identifying potential issues in navigation, clarity of instructions, and overall user experience. The results are presented in Table 6.

Table 6. One-to-One Evaluation Results

No	Student	Percentage	Criteria
1	Student 1	92%	Highly Practical
2	Student 2	96%	Highly Practical
3	Student 3	90%	Highly Practical
Average		**93%**	**Highly Practical**

The findings show that all three students rated the media in the "Highly Practical" category, with an average practicality score of 93%. This indicates that the design features (including interface layout, button placement, instruction clarity, and feedback mechanisms) were intuitive and accessible even for students with lower mathematical proficiency. The high level of practicality at this early stage illustrates that the learning media successfully supports

autonomous learning. Students could navigate the game without teacher assistance, demonstrating that the interaction design effectively reduces dependency on external guidance. Furthermore, students' verbal comments indicated that the game elements created a sense of challenge and goal orientation, which increased their willingness to explore the content more deeply. This aligns with literature indicating that well-designed digital games can foster intrinsic motivation and enhance exploratory behavior in learning environments.

Small-Group Evaluation

Following revisions based on expert feedback and the one-to-one evaluation, the media was tested with a small group of six students. The purpose of this stage was to observe interactions in a collaborative setting and to examine how the media performs with multiple simultaneous users. The results are presented in Table 7.

Table 7. Small-Group Evaluation Results

No	Student	Percentage	Criteria
1	Student 1	97%	Highly Practical
2	Student 2	97%	Highly Practical
3	Student 3	92%	Highly Practical
4	Student 4	90%	Highly Practical
5	Student 5	97%	Highly Practical
6	Student 6	95%	Highly Practical
Average		**94%**	**Highly Practical**

All students rated the media within the "Highly Practical" range, with an average score of 94%. The small-group evaluation demonstrates a positive upward trend from the one-to-one evaluation (93%) to the small-group phase (94%). This improvement indicates that the iterative refinement process effectively enhanced overall usability and content flow. Students also interacted socially around the game tasks, discussing strategies and verifying answers, suggesting that the media encourages collaborative learning dynamics. Moreover, the increased enjoyment reported by students highlights the motivational power of game-based design, which is known to promote persistence, attention, and emotional engagement during learning.

Field Test

After undergoing revisions, the improved version of the media was implemented in a classroom setting with 25 students during the field test. This stage aimed to measure large-scale practicality and evaluate the media's performance when used simultaneously by many learners. At the end of the learning session, students completed a practicality questionnaire. The results showed that the learning media achieved a practicality score of 95%, placing it within the "Highly Practical"category. These findings demonstrate that the media maintains high usability and functional stability when applied in real classroom conditions. The strong practicality score shows that mobile accessibility successfully addressed previous barriers, especially students' limited access to learning resources outside school hours. Observations during the field test also revealed increased engagement, with students independently exploring game levels and attempting to improve their scores. This behavior suggests that the interactive design and reward structure support sustained engagement, autonomy, and self-regulated learning, key indicators of effective digital learning environments.

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Summative Evaluation (Effectiveness Test)

To evaluate the effectiveness of the media, a posttest was administered to all 25 students, with 24 of them successfully achieving the minimum mastery criterion. This outcome produced an overall mastery level of 96%, placing the Construct 2–based learning media in the "Highly Effective" category. The high level of mastery indicates that the media does more than simply increase motivation; it also plays a substantive role in strengthening students' conceptual understanding of three-dimensional geometry. The interactive simulations and animations embedded in the media enhanced students' ability to interpret spatial relationships, thereby reducing cognitive load and helping them connect visual representations with abstract concepts. Game-based quizzes provided immediate feedback, which encouraged repeated practice and supported the consolidation of procedural and conceptual knowledge. The scaffolded difficulty levels also enabled learners with varying proficiency to progress at a pace aligned with their needs, demonstrating the media's capacity to support differentiated learning. Moreover, mobile accessibility allowed students to engage with the material beyond classroom hours, extending their exposure to geometric concepts and improving retention. Collectively, these mechanisms transformed previously identified challenges, particularly students' difficulties in visualization and their low engagement levels, into opportunities for deeper comprehension, persistence, and active participation. The findings confirm that the Construct 2–based learning media not only addresses the instructional problems revealed during preliminary research but also enhances learning outcomes in a substantial and measurable way.

Discussion

The development of learning media using Construct 2 for teaching three-dimensional geometry integrates instructional content with interactive game-based quizzes covering triangular prisms, cylinders, square pyramids, cones, and spheres. The media was designed to help students understand geometric concepts more effectively, increase their interest in learning, and provide easier access to instructional materials through both mobile applications and HTML5 platforms. The design aligns with the findings of Freeman et al (2020), Hsieh et al (2025), and Rocha (2020), who demonstrated that Construct 2–based applications can enhance students' conceptual understanding of solid figures, particularly through interactive and visual features that traditional instructional methods do not provide.

This study adopted development model, consisting of preliminary research, prototyping, and summative evaluation. Across these stages, the learning media demonstrated strong validity, practicality, and effectiveness. The media's high validity reflects its alignment with curriculum content, while the practicality assessments showed that students could navigate the media independently and found the game-based features engaging. The summative evaluation further confirmed that the media effectively supported the learning of three-dimensional geometry, particularly for students who previously struggled with visualizing solid shapes from their nets.

Initial observations and interviews revealed that students experienced persistent difficulties in distinguishing various types of three-dimensional figures and translating between nets and solid shapes. They also had limited exposure to digital instructional tools, as learning activities were dominated by teacher-centered methods and textbook-based explanations. The decision to design an educational game was based on the premise that game-based learning offers a motivating and accessible way to reinforce mathematical concepts. As described by Kärki et al (2022) and Nisa & Susanto (2022), educational games support conceptual

understanding by embedding learning elements (questions, feedback, and representations) within interactive gameplay.

One of the key strengths of Construct 2–based learning media is its ability to present learning content in a visually appealing and dynamic manner. The animations, images, and transitions help students visualize geometric forms more clearly, reducing cognitive load and supporting conceptual development. This aligns with Kärki et al (2022), who noted that educational games enhance student motivation and help alleviate learning fatigue. Moreover, the motivational mechanisms embedded in the game (such as challenges, rewards, level progression, and opportunities for replay) further support student engagement and persistence, as highlighted by Nisa & Susanto (2022).

The media was found suitable for middle school learners, supported by expert validation results, student feedback in one-to-one and small-group evaluations, and positive responses during the field implementation. The game's structure requires players to overcome obstacles, avoid virtual enemies, and answer embedded questions correctly to progress, thereby fostering both cognitive and affective engagement. The inclusion of visual elements, such as animations of nets transforming into solid figures, supports students' spatial reasoning and aligns with research showing that digital media can enhance visualization skills in geometry (Harris et al., 2023). Additionally, previous studies by Clark-Wilson et al. (2020), Hsieh et al. (2025) and Rocha, 2020) found that mobile game–based learning environments increase motivation and promote independent learning, which is consistent with the behavior observed in this study.

The media's high level of practicality in classroom implementation demonstrates that students were able to use the platform with ease, and its mobile accessibility enabled learning beyond school hours. The effectiveness results indicate that most students achieved mastery in the targeted competencies, confirming that the media not only motivates learners but also contributes meaningfully to their conceptual understanding of three-dimensional geometry. This study extends previous research by demonstrating how Construct 2 can be used not only as a validation-proven learning tool but also as an effective pedagogical intervention that addresses specific visualization barriers in three-dimensional geometry. Unlike earlier studies that focused primarily on feasibility or student perceptions, this study provides evidence across three dimensions (validity, practicality, and effectiveness) showing that game-based media can serve as a comprehensive solution for learning challenges in geometry. The integration of dynamic visualizations, interactive feedback, and mobile accessibility positions this media as an innovative learning resource that enhances both student motivation and conceptual mastery.

Conclusion

This study demonstrates that Construct 2–based learning media can serve as an effective pedagogical intervention for improving students' understanding of three-dimensional geometry. The media developed through the Akker model achieved strong validity, high practicality, and substantial effectiveness across all stages of evaluation, indicating that the integration of game-based elements, visual animations, and mobile accessibility provides a robust learning environment for middle school students. The findings show that the media not only enhances student motivation but also addresses persistent obstacles in geometry learning, particularly the difficulty of visualizing nets and solid shapes. The study contributes to the literature by providing comprehensive evidence that game-based learning media can bridge the gap between abstract geometric concepts and students' need for concrete visual representation. Unlike earlier research that focused mainly on feasibility or perception, this study demonstrates the pedagogical impact of Construct 2 through measurable improvements in conceptual understanding and learner engagement. The results underscore the potential of integrating interactive digital tools into mathematics instruction to support differentiated learning,

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strengthen spatial reasoning, and promote autonomous learning beyond classroom boundaries. Despite its promising results, the study is limited to a single school context and focuses solely on three-dimensional geometry content. Future research should explore the scalability of this media across diverse school settings, investigate its long-term effects on learning retention, and examine its applicability to other mathematical domains that require visual–spatial reasoning. Further work might also integrate adaptive learning pathways or analytics-based feedback to personalize the learning experience. Overall, the study reinforces the value of combining game-based design with structured pedagogical frameworks to enhance mathematics learning in the digital era.

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' Contributions

The first author, A.D.M., contributed to data collection, research instrument preparation, instrument validation, theoretical development, methodology, data organization and analysis, as well as the interpretation of findings. The second and third authors, I.D. and C.M.L., contributed to reviewing and refining the manuscript and ensured that the final version of this article was read and approved. The percentage contributions to the conceptualization, preparation, and revision of this manuscript are as follows: A.D.M.: 60%, I.D.: 20%, and C.M. L.: 20%.

Data Availability Statement

The authors state that the data supporting the findings of this study will be made available by the corresponding author, [A.D.M.], upon reasonable request.

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