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Integration Of Steam With Constructed Network Media To Improve Mathematics Learning For Class VIII Junior High School Students

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Abstract

This research aims to develop manipulative media for geometric nets to support geometry learning in junior high schools using the Borg and Gall model Research and Development (R&D) method. This media is designed to visualize concrete spatial concepts, increase student interaction, and support the achievement of the Independent Curriculum. Validation shows this media is curriculum-appropriate, mathematically accurate, and practical even though it requires increased durability of digital materials and illustrations. Practicality tests show this media is effective in making abstract concepts more concrete, increasing understanding of students with visual and kinesthetic learning styles, and motivating active involvement, although auditory students require additional guidance. Large-scale implementation shows that this media increases understanding of concepts, learning motivation, and makes learning more interesting. Recommendations include the use of more durable materials, the integration of digital technology, and teacher training to optimize its use.

INTRODUCTION

The rapid development of science and technology in recent decades has had a significant impact on the advancement of knowledge. However, despite much progress that has been made, there are still various social and environmental problems that require serious attention, such as global warming and the health crisis. These problems cannot be solved by just one discipline but require an interdisciplinary approach that creatively integrates various disciplines. In the context of education, an approach that prioritizes the integration of these disciplines is becoming increasingly important. One popular approach is STEM (Science, Technology, Engineering, and Mathematics), which later developed into STEAM with the addition of art elements. Research shows that the STEAM approach can significantly develop early childhood creativity through innovative learning methods (Rachmadtullah et al., 2021). In addition, the implementation of STEAM in elementary schools has helped improve students' critical thinking skills and scientific literacy (Widodo et al., 2020).

STEAM refers to the integration of Science, Technology, Engineering, Art, and Mathematics and is considered an innovation in education that can provide a more holistic and engaging learning experience. In this approach, science serves to improve students'

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understanding of natural phenomena and basic concepts, while technology is used as a tool to solve problems and create innovation. Engineering focuses on the application of scientific principles in design and construction, while art provides space for the expression of creativity and innovative ideas. Mathematics, as a discipline that underlies the use of language in science and technology, plays an important role in analysis and problem-solving. The application of STEAM in education has been shown to improve 21st-century skills, such as critical thinking and problem-solving, especially in the madrasah ibtidaiyah environment (Aini & Supriyadi, 2022).

By adopting the STEAM approach, mathematics learning can be more interesting and enjoyable. Integrating art elements into learning not only enhances students' creativity but also facilitates more effective problem-solving. Art can encourage independent learning, a sense of social responsibility, and collaborative skills among students. However, the implementation of STEAM in education is not without challenges. One of the main problems is the poorly integrated curriculum in schools. Many educational institutions still separate subjects, which makes it difficult to combine STEAM elements in one holistic learning (Sutrisno et al., 2019). The inability of teachers to integrate various disciplines is also an obstacle. Many teachers are accustomed to traditional teaching methods and lack adequate training to implement STEAM. In addition, support from stakeholders, such as the government, parents, and communities, is often minimal, hampering the implementation of this approach.

On the other hand, assessments that still focus on quantitative outcomes, such as test scores, do not value creativity and collaboration, which are at the heart of the STEAM approach. Therefore, there is a need for reform in the assessment system to create a more supportive learning environment. The challenge of student motivation cannot be ignored either. Students who are accustomed to conventional learning methods may find it difficult to engage in projects that require a multidisciplinary approach, which often leads to a decrease in their self-confidence.

To overcome these challenges, innovative and inclusive solutions are needed. STEAM programs that involve the participation of female students and students with special needs, as well as the use of project-based learning approaches, are important steps in increasing student engagement. Integrating STEAM into existing subjects can also help reduce the burden on the curriculum while still meeting the needs of comprehensive learning.

In addition, previous studies have shown that the use of appropriate learning media can increase students' interest and involvement in learning. For example, research conducted by Aprilia et al. (2023) revealed that the application of the STEAM-PjBL method to the material on the volume of geometric shapes in elementary schools significantly improved students' understanding. Similar findings were also conveyed by Khadifin et al. (2022), which showed that the STEAM approach had a positive impact on student learning outcomes. These studies emphasize the importance of developing interactive and collaborative learning methods to help students understand mathematical and scientific concepts more deeply.

This article aims to examine the urgency of implementing the STEAM approach in mathematics learning, identify the obstacles faced in its implementation, and offer concrete solutions to increase the effectiveness of this approach. By understanding the challenges and solutions that exist, it is hoped that the application of STEAM in the education system can be applied more widely, so that students are not only ready to face academic challenges, but also develop into innovators who are able to solve complex problems in society.

METHOD

The research approach used in this report is Research and Development (R&D), which, according to Sugiyono (2019), is a systematic method for generating new knowledge, solving problems, or developing products, processes, or services. This method is widely applied in various fields, including education, to create more efficient and effective products or services.

In this study, the product developed is a spatial net media as a mathematics learning aid to make it easier for students to understand geometric concepts. The stages in R&D research include needs analysis, product design planning, validation by experts (media and materials), user trials (teachers and students), and evaluation for further improvement. This development process refers to the model proposed by Borg & Gall (2003), which emphasizes product validation by experts and field trials to ensure its effectiveness and feasibility.

Data analysis techniques used in this study include thematic, comparative, and triangulation analysis. Data were obtained through interviews with media experts, material experts, teachers, and students. This approach is considered relevant in the development of innovative learning media that can support learning more effectively.

RESULTS

The results of testing and analysis of the manipulative media "GeoNet: Interactive Spatial Nets" show that this media received positive assessments from various parties, although there were several recommendations for improvement.

In the media validity test, this media was validated by two media experts, who gave an average score of 85 out of 100, which is included in the very feasible category. The experts recommended increasing the durability of the material to make it more durable and the inclusion of digital illustrations as a complement to support students with different learning styles.

Furthermore, in the material validity test, validation was carried out by two material experts, who assessed the media based on three main aspects. First, in terms of suitability with the curriculum, this media is by the Merdeka Curriculum for junior high school students in grade VIII, especially in geometry competencies, because it allows students to explore contextual learning. Second, in terms of integration with mathematical concepts, the experts ensured that the spatial nets provided accurately depict geometric elements, including edges, sides, and vertices. Third, in terms of practicality of use, this media is considered easy to use in daily learning, although teachers need to manage their

time well when implementing it in class. From the results of this validation, the media obtained an average score of 88 out of 100, which is included in the very feasible category.

In the practicality test by the teacher, the teacher who tested this media stated that this media was very helpful in bridging abstract concepts into concrete forms, making it easier for students to understand. However, the teacher also considered that further training was needed to optimize the use of this media in project-based or collaborative learning.

Finally, in testing on students, the results of the trial showed that students felt more enthusiastic and motivated when using this media. Understanding of geometric concepts increased significantly, especially for students with visual and kinesthetic learning styles. However, students with auditory learning styles tend to need additional guidance from teachers to better understand the steps of using the media.

With the results of this validation and testing, the manipulative media "GeoNet: Interactive Space Building Nets" can be recommended as an effective learning aid to improve students' understanding of geometry, with several improvements suggested to optimize its use in the learning process.

Figure 1. Media Trial to Students

DISCUSSION

The STEAM approach creates a holistic learning experience by creatively integrating various disciplines. In mathematics learning, STEAM allows students to understand abstract concepts concretely. Through engineering and art elements, abstract mathematical concepts such as surface area and volume can be visualized in real forms using manipulative media. In this case, geometric nets are an effective tool in helping students understand the concept (Aprilia et al., 2023). In addition, this approach also develops 21st-century skills, such as critical thinking, collaboration, and creativity. For example, students who use geometric net media are invited to explore how to calculate surface area independently with a project-based approach (Khadifin et al., 2022).

The STEAM approach also connects mathematics with real life, allowing students to understand the relevance of mathematics in various aspects, such as architecture, art, and design (Yulianti, 2021). At the define stage, this study identified that students had difficulty understanding the relationship between nets and geometric shapes and applying the concept of surface area in three dimensions. This difficulty shows the need for

manipulative media that can visualize concepts concretely, involve students interactively, and cover various types of geometric shapes according to the learning achievements of the Independent Curriculum (Susanto, 2020). Therefore, the development of manipulative media for geometric nets is directed to meet these needs so that learning becomes more effective, relevant, and interesting.

At the design stage, manipulative media in the form of a three-dimensional geometric net was designed using simple materials such as manila paper. This media was chosen because it is effective in visualizing three-dimensional geometric shapes at a relatively low cost and is easy for students to use (Rahmawati, 2019). Research instruments, such as validation sheets and trials, were also designed to obtain input from media experts, material experts, teachers, and students. In addition, this design is equipped with a media usage guide so that it can be optimally implemented in mathematics learning.

Furthermore, at the development stage, the manipulative media prototype was developed according to the plan that had been made and validated by experts, teachers, and students to ensure its suitability, practicality, and attractiveness. Media expert validation was carried out by three experts who gave an average score of 88.7 on a scale of 100, indicating that this media meets the eligibility standards with several recommendations for improvement, such as increasing the durability of the material and including digital illustrations for students with different learning styles (Setiawan et al., 2023). The validation of material experts assessed this media based on three main aspects, namely suitability to the curriculum, integration with mathematical concepts, and practicality in use. The validation results showed that this media was by the Merdeka Curriculum for junior high school grade VIII, with an average score of 90.2 on a scale of 100 (Hidayat et al., 2022).

Practicality testing by teachers was also carried out to assess the extent to which this media can be used in daily learning. Teachers assessed that this media helps students understand abstract concepts more concretely, although additional training is needed so that its integration into project-based or collaborative learning methods can run more effectively (Sari, 2021). Testing of students showed that students were more enthusiastic and motivated when using this media. Concept understanding increased significantly, especially in students with visual and kinesthetic learning styles, while students with auditory learning styles required additional assistance from teachers in understanding the steps of its use (Anggraini et al., 2020).

The final stage, namely dissemination, ensures that this media can be implemented widely through full-class implementation and training for other teachers. With the support of socialization and publication in educational journals, this media is recommended for use in various schools (Yusuf, 2022). Large-scale evaluations show the effectiveness of this manipulative media in improving student understanding, strengthening learning motivation, and making learning spatial shapes more enjoyable. Thus, the manipulative media of spatial nets is a viable alternative to be applied in mathematics learning based on the Independent Curriculum.

CONCLUSION

This study shows that the STEAM approach and the use of manipulative media of geometric nets are effective in improving students' understanding of geometric concepts. This media helps students visualize the relationship between nets and geometric shapes in a concrete way, thus facilitating learning.

Expert validation shows that this media is in accordance with the Independent Curriculum, has good integration of mathematical concepts, and is quite practical to use, although improvements are needed in the durability of materials and digital illustrations. Teachers and students also gave positive responses, with visual and kinesthetic students feeling greater benefits, while auditory students still need teacher assistance.

Overall, this study proves that STEAM and manipulative media can be innovative solutions in mathematics learning. With wider implementation, this media has the potential to increase the effectiveness of geometry learning at various levels of education.

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