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Development of Mathematics Learning Media on Build Flat Side Space Using Smart Apps Creator

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ABSTRACT

Learning mathematics in the subject of Build Flat-Side Space remains a challenge for junior high school students due to limited visual representation and minimal use of technological media that can facilitate spatial understanding. The abstract nature of shape concepts requires clear visualization, but conventional learning practices tend to rely only on static images in textbooks. This condition has an impact on the low level of concept understanding and learning motivation of students. *Smart Apps Creator* (SAC) as an interactive media development tool has the potential to provide dynamic visualizations and a more interesting learning experience. This study aims to develop SAC-assisted mathematics learning media and test its validity, practicality, and effectiveness in supporting the learning of flat-sided shapes. The study uses the *Research and Development* (R&D) method with the ADDIE model, which includes the stages of needs analysis, product design, media development, classroom implementation, and evaluation. The research instruments consisted of expert validation sheets for material and media, student questionnaires, and learning outcome tests. The validation process was carried out to assess the suitability of the content, appearance, and usefulness of the media, while the practicality and effectiveness tests were conducted through the use of media in classroom learning. The results showed that the SAC-based learning media achieved a highly valid rating from experts, was practical based on user responses, and was effective in increasing motivation and understanding of flat-sided spatial concepts. Thus, this media can be used as an alternative interactive learning resource that supports a more interesting, meaningful, and needs-based mathematics learning process for junior high school students.

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Introduction

Learning mathematics in the subject of build flat-side space is one of the main challenges for junior high school students because this subject requires strong spatial visualization skills (Harris et al., 2023; Kosko, 2020; Patahuddin et al., 2022). Many students have difficulty understanding the shapes, sizes, and relationships between the elements of shapes when learning relies solely on verbal explanations (Qadry et al., 2022). The dominant one-way learning approach makes students less engaged and unable to construct understanding independently (Muzaini et al., 2023; Yao & Manouchehri, 2019; Zambak & Tyminski, 2020). Previous research shows that this difficulty is exacerbated by limited visual representation, making the concept of spatial figures feel abstract and difficult to understand (Montenegro et al., 2018). This condition indicates that mathematics learning needs to be supported by media that can bridge abstraction to concrete visualization.

Variations in comprehension levels, learning speeds, and learning profiles among students add complexity to mathematics learning in junior high school (Mentari & Syarifuddin, 2020; Noguez & Neri, 2019; Rodríguez-Muñiz et al., 2022). Some students find it easier to understand material through verbal explanations, while others need visualizations or direct learning experiences to understand the same concepts (Castro et al., 2022). This mismatch in learning styles often makes mathematics learning feel difficult for most students. The use of technology can actually help accommodate these learning needs. However, the use of learning technology in schools, especially in mathematics, is still minimal (Hsieh et al., 2025; Rocha, 2020). This shows that there is a gap between the needs of students and the learning practices that take place in the classroom.

Theoretically, ideal mathematics learning emphasizes interaction between teachers, students, materials, facilities, and complementary learning procedures (Schulz, 2023). Bruner (Gasteiger et al., 2020) also emphasizes that mathematics learning should enable students to gradually discover the concepts and structures underlying a subject. Thus, mathematics learning is not just a process of delivering material, but a pedagogical interaction that allows students to build connections between mathematical ideas and structures (Fredriksdotter et al., 2022; Olsher et al., 2025; Walkington et al., 2024). When the supporting elements of learning are not maximized, the learning process becomes meaningless for students. Therefore, learning media that can accommodate these needs and enrich the learning experience of students are needed.

The implementation of the Merdeka Curriculum further emphasizes the need for relevant, flexible, and differentiated learning (Charitas et al., 2023; Rezat et al., 2021; Voigt et al., 2020). This curriculum emphasizes diagnostic assessments to map students' readiness, interests, and learning profiles as a basis for determining learning strategies. Learning differentiation includes differentiation of content, process, and product, which aims to tailor the learning experience to the needs of each student. Differentiated learning requires teachers to provide a variety of learning resources, including accessible and engaging technology-based media. Thus, the existence of interactive and adaptive learning media is crucial in supporting the optimal implementation of the Merdeka Curriculum.

Observations and interviews with mathematics teachers at SMP Negeri 1 Tombatu show that mathematics learning is still monotonous and lacks innovation. Teachers tend to use textbooks and online videos without supporting activities that encourage exploration of spatial concepts. As a result, students feel bored and have difficulty understanding abstract material. The absence of interactive media makes the learning process less interesting and unable to stimulate deep understanding. This reinforces the need for learning media that can provide a more enjoyable and meaningful learning experience for students.

Technology-based learning media, especially ICT media, offer great opportunities to improve the effectiveness of mathematics learning (Asami-Johansson et al., 2020; Hernández

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et al., 2020; Jankvist & Niss, 2020). ICT media can provide dynamic visualizations, direct interaction, and flexibility of access that traditional manipulative media do not have (Öçal et al., 2020). *Smart Apps Creator* (SAC) is media development tool that allows the creation of interactive learning apllications whitout requiring programming skills. This application can be accessed through various platforms such as smartphone, labtops, and HTML5, making it easy to use for teacher and student (Swidan & Fried, 2021). The use of SAC has the potential to help students understand flat-sided shape through interactive visualizations and simulations. Previous studies have shown that SAC-based learning media can increase students' interest and motivation to learn, and are effective as a support for independent learning (Günster & Weigand, 2020; Ratnayake et al., 2020; Rocha, 2020). Given this potential, the development of interactive learning media using SAC for flat-sided shapes is highly relevant. This media is expected to clarify concepts, visualize 3D objects, and significantly improve students' understanding. Based on this description, the researcher was interested in developing "Mathematics Learning Media On Build Flat-Side Space Using *Smart Apps Creator* (SAC)" to support the quality of mathematics learning in junior high schools.

Method

Type of Research

This research is a research and development (R&D) study. The development model used is ADDIE (*Analysis, Design, Development, Implementation, Evaluation*). This model was chosen because it provides systematic steps for developing learning products and testing their validity, practicality, and effectiveness. The development process includes needs analysis, media design, product development, classroom implementation, and evaluation of results.

Population and Sample

The research subjects in this study consisted of two main groups. The first group was experts or validators, consisting of four experts who assessed the material and media aspects to determine the validity level of the developed product. The second group consists of eighth-grade students from SMP Negeri 1 Tombatu in the 2024/2025 academic year, who were used as subjects in small group trials and field trials to assess the practicality and provide feedback on the use of learning media. Through the involvement of these two groups, the process of developing learning media can be evaluated comprehensively in terms of validity, practicality, and effectiveness.

Instrument

The research instruments used in this study consisted of several types to support a comprehensive product assessment process. Expert validation sheets were used to assess the validity of the media in terms of content, material presentation, appearance, and suitability for learning objectives. In addition, a practicality questionnaire for students was used to determine the ease of use, attractiveness, and usefulness of the learning media when applied in the teaching and learning process. The next instrument was a learning outcome test, which served to measure the effectiveness of the media in improving students' understanding of build flat-side space. To complete the data, an interview guide is also used to enable researchers to obtain input, criticism, and suggestions from teachers and students regarding improvements to the learning

media. All of these instruments complement each other to ensure that the media developed meets the aspects of validity, practicality, and effectiveness.

Procedures

This research procedure follows the ADDIE model, which consists of five main stages: analysis, design, development, implementation, and evaluation. In the analysis stage, researchers identify needs through observation and interviews to determine learning conditions, student difficulties, and the availability of media used by teachers. In addition, a curriculum analysis is conducted to determine basic competencies, materials, and the depth of flat-sided spatial concepts. The design stage was carried out by compiling the initial design of learning media assisted by *Smart Apps Creator* (SAC), including material compilation, storyboard creation, display design, and the compilation of research instruments such as validation sheets, questionnaires, and learning outcome tests. Next, in the development stage, the initial design was realized into a learning media product through Smart Apps Creator, then validated by experts to assess the validity of the content, appearance, and feasibility of the media. The implementation stage was carried out by testing the revised media on students in class VIII C through small group tests and field tests to determine the practicality and effectiveness of the media. The final stage was evaluation, in which the researchers analyzed the results of expert validation, student responses, and learning outcome tests to assess the quality of the media. Input from the evaluation stage was used to make final revisions so that the learning media was ready for use in real learning.

Data Analysis

Data analysis in this study was conducted using descriptive qualitative and descriptive statistical methods in accordance with the product development objectives. Data from the expert validation sheet was analyzed using percentage calculation techniques to determine the validity level of the media based on the scores given for content, appearance, and presentation quality. Practicality data was obtained from student response questionnaires, which were analyzed by calculating the percentage of achievement to determine the practicality category of the media. Furthermore, effectiveness analysis was carried out using student learning test results, by calculating the percentage of mastery based on the number of students who achieved the Minimum Mastery Criteria. The results of the analysis of the three aspects—validity, practicality, and effectiveness—were used to determine the final quality of the learning media assisted by *Smart Apps Creator* (SAC) and to ensure that the media was suitable for use in mathematics learning.

Research Findings

Analysis Stage Results

This analysis stage was conducted as a means of gathering the information and field data needed by researchers to design a learning media application developed with the help of *Smart Apps Creator* (SAC). The results obtained through interviews with mathematics teachers at SMP Negeri 1 Tombatu: The curriculum used is the Merdeka Curriculum, students need the use of learning media that utilizes technology in learning so that learning can be more effective and make it easier for students to understand the learning material practically. Flat-sided shapes material is systematically included in the eighth-grade material.

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Design Stage Results

In this study, based on the analysis stage, the learning media design stage includes: preparing reference books related build flat-side space for eighth-grade junior high school students based on the Merdeka Curriculum, systematically compiling the learning media display framework in accordance with the material used in the product development process, designing the background display, menus, images, and text using other applications such as Canva, creating 3D models of objects to be visualized using the 3D design application Blender, determining the design for the learning media display to make it attractive, as well as ensuring the material is well-organized and structured, and compiling the design of the learning media evaluation instrument. Figures 1 show several learning media design displays before validation.

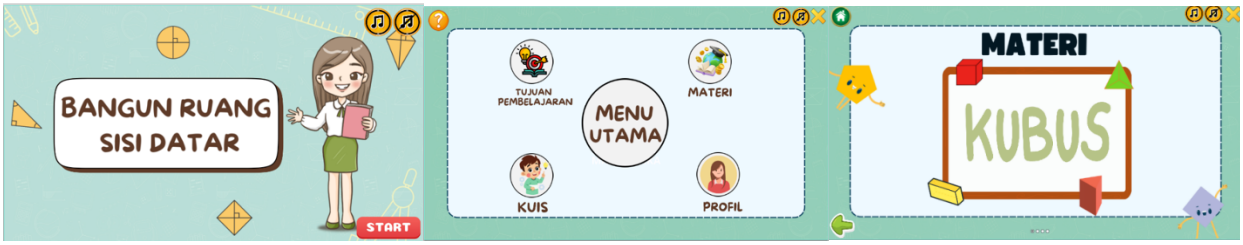


Figure1. Title Page Display, Main Menu, and Materials

Development Stage Results

Media Expert Validation

Media validation consists of five aspects, namely visual appearance, font usage, language sound, and ease of use. This was completed by a Mathematics Education lecturer at Manado State University.

Table 1. Results Expert Validation Results

Validator	Percentage	Criteria
Validator 1	80 %	Valid
Validator 2	95 %	Highly Valid
Average	87,77 %	Highly Valid

According to the data shown in Table 1, the overall score for various aspects obtained from the second media expert validator was 87.77% and was classified as "Highly Valid."

Expert Validation

Content validation involves two components, namely content and language, which were carried out by a mathematics education lecturer at Manado State University and a teacher at SMP Negeri 1 Tombatu.

Tabel 2. Result of Material Expert Validation

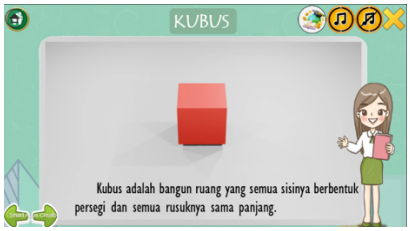
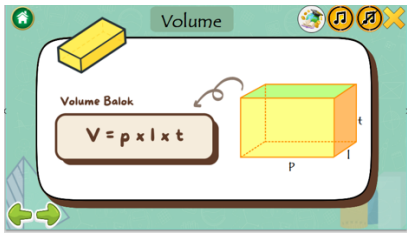
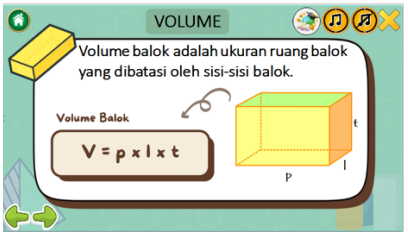
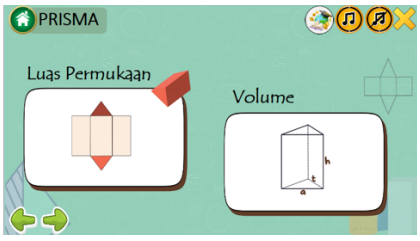
Validator	Percentage	Criteria
Validator 1	97 %	Valid
Validator 2	90 %	Highly Valid
Average	93,33 %	Highly Valid

According to the data listed in Table 2, the overall score for various aspects assessed by two subject matter experts reached 93.33% and was classified as "Highly Valid".

Product Revision

Product revision based on recommendations and feedback received. The results of suggestions and revisions for learning media can be seen in Table 3.

Tabel 3. Product Revision

No	Image
1.	Suggestion: Remove the text material, enlarge the font size and images, and separate the spatial images for each material. Before Revision  After Revision 
2.	Suggestion: Change the font color of the cube text and avoid excessive blank space (enlarge the cube images and material), and replace the teacher animation image. Before Revision  After Revision 
3.	Suggestion: Add material about the volume of a block. Before Revision  After Revision 
4.	Suggestion: Remove the white box, change the text and *font of* the prism. Before Revision  After Revision 

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After the learning media went through the product revision stage, it was ready to be implemented in learning. The final result of the learning media can be accessed via the following link: ***https://bit.ly/4k3icFj***

Implementation Stage Results

This stage was carried out at SMP Negeri 1 Tombatu, with 20 eighth-grade students from class VIII C as the main target participants. Based on the data obtained, the practicality level of the learning media was "Very Practical," with an average percentage of 91.21%.

Evaluation Stage Results

The final stage is *evaluation, where* an analysis is conducted to evaluate the data obtained from the learning outcome tests. A total of 25 students took this test to assess the effectiveness of the learning application used. From the learning test results, 23 students achieved scores above the minimum passing grade (75), while the other two students did not reach the minimum passing grade. Thus, the percentage was 92%, indicating that the results obtained were in the "Very Effective" category.

Discussion

The development of learning media assisted by *Smart Apps Creator* (SAC) on flat-sided Shapes figures aims to overcome students difficulties in understanding abstract concepts. This media is designed to display three-dimensional visualizations, spatial figure nets, and interactive exercises that clarify the structure of geometric objects (Harris et al., 2023). These features provide a more concrete learning experience compared to the use of textbooks alone. In addition, SAC allows students to learn independently because it can be accessed through digital devices whenever needed (Jenßen et al., 2022; Powell et al., 2020). With visualization and direct interaction, students can build conceptual understanding more easily and meaningfully.

The analysis stage in the ADDIE model shows that mathematics learning is still centered on the use of textbooks and several video presentations. This condition makes the learning process monotonous and does not actively involve students. The lack of media variety makes it difficult for students to visualize spatial figures, especially concepts that require spatial representation (Harris et al., 2023; Patahuddin et al., 2022). The Merdeka Curriculum applied in the school requires teachers to provide learning resources that are more contextual, adaptive, and student- centered. Therefore, the integration of SAC-based interactive media is relevant to improve the quality of learning.

During the design stage, the media is developed through a process of planning the layout, navigation, sequence of material, and presentation of supporting images. The initial design also includes the creation of visual models and graphic elements to support the understanding of spatial concepts (Bos et al., 2020; Khozaei et al., 2022; Kotsopoulos et al., 2017). Instruments such as validation sheets and student response questionnaires are also prepared to ensure that the quality of the media can be accurately measured. The design stage provides a comprehensive overview of the media structure before it is realized in the form of an application. With careful planning, the learning media has a clear framework and is ready to be developed in the next stage.

The development stage produces a learning media prototype, which then undergoes a validation process by subject matter experts and media experts. Validation is carried out to

ensure the accuracy of the content, the appropriateness of the display, and the clarity of the learning flow presented in the application. Feedback from validators is used to improve deficiencies, ranging from visual layout, material completeness, to the integration between appearance and function (Fredriksdotter et al., 2022; Olsher et al., 2025; Walkington et al., 2024). This process is important so that the media is not only visually appealing, but also academically accurate. Through validation, the learning media becomes more ready to be implemented in real learning in the classroom.

The media was implemented by testing it on students learning mathematics material on flat-sided shapes. At this stage, students showed greater enthusiasm because the media offered an interactive learning experience and was easy to operate. 3D visualizations and nets of solid figures helped students understand the relationship between spatial shapes and their representations (David et al., 2018). In addition, simple navigation allowed students to learn without technical barriers. Overall, the implementation showed that SAC-based media can encourage students to become more involved in the learning process.

The evaluation stage aims to review the effectiveness of the media after it has been used in learning. The evaluation results show that students are better able to understand geometric concepts because they are assisted by visual displays and interactive examples in the application. This media also provides opportunities for students to explore the material independently, thereby increasing their confidence in learning. In addition, positive responses from students and teachers indicate that this media meets learning needs in accordance with the requirements of the Merdeka Curriculum. Thus, the development of SAC-assisted media can be an effective and relevant alternative solution to improve the quality of mathematics learning in junior high schools.

The findings of this study provide theoretical reinforcement that the use od technology-based media, particularly SAC, can bridge the gap between abstract and concrete representations in mathematics learning. Pedagogically, this media supports the principle of constructivism, whereby students construct knowledge through direct interaction with objects and visualization of concepts (Patahuddin et al., 2022). The use of SAC is also in line with the demands of 21st-century learning, which emphasizes digital literacy, creativity, and spatial thinking skills. From a practical standpoint, this media is relevant for application in various classroom contexts because it is flexible, easily accessible, and can be used in both face-to-face and independent learning. Through the integration of this technology, teachers can facilitate more student-centered learning and encourage students to be more active in understanding spatial structures in depth.

Conclusion

This study produced a mathematics learning medium on build flat-side space using *Smart Apps Creator* (SAC), which underwent the ADDIE model development process from needs analysis to final evaluation. This medium is considered suitable for use in learning because it provides attractive, interactive visualizations that make it easier for students to understand abstract geometric concepts. The implementation of the media showed that students were more interested and found it easier to understand the material when they interacted with three-dimensional displays and nets of solid figures. In addition, teachers felt that this media was helpful because its display and navigation were simple and in line with the requirements of the Merdeka Curriculum. Overall, the developed media has met the aspects of validity, practicality, and effectiveness based on the development process carried out.

This study has several limitations that need to be considered in further development. The learning media developed only covers flat-sided spatial figures for eighth grade, so it cannot be used for other mathematics materials that require similar visualization. In addition, the trial was

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conducted on a limited scale, so it does not yet describe the broader response of students in various school conditions. Differences in access to digital devices among students also pose a challenge, especially for students who do not have smartphones or stable internet connections. Time constraints during implementation prevented researchers from monitoring students' understanding in the long term.

Given these limitations, further research is recommended to develop SAC-based learning media for other mathematics subjects that require complex visualization, such as transformational geometry or statistics. Further research could also involve a more diverse range of schools and students to obtain stronger generalizations of the results. In addition, additional features such as interactive simulations, educational games, or automated digital evaluation need to be developed to make the media more attractive and adaptive to students' needs. Subsequent researchers may also review the long-term impact of media use, for example through longitudinal studies to observe the continuous development of students' conceptual understanding. By expanding the scope and deepening the analysis, technology-assisted learning media such as SAC can make a greater contribution to improving the quality of mathematics learning in schools.

Conflict of Interest

The researcher revealed that there was no conflict interest.

Authors' Contributions

The first author, T.M.O., contributed as the researcher, collecting data and discussing the results. The other authors, M.S. and D.F.K, participated in revising and refining this article. The total percentage of contributions to the conceptualization, writing, and correction of this article is as follows: T.M.O.: 70%, M.S.: 15%, and D.F.K.: 15%.

Data Availability Statement

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

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