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Is android-based learning media effective for exploring students' spatial ability??

Evi Latifatus Sirri[1] *, Nani Ratnaningsih[2] , Puji Lestari[3]
[1]Mathematics Education Study Program, Siliwangi University, Jalan Siliwangi No 24 Kota Tasikmalaya, Indonesia.
E-mail:[1] evilatifa24@gmail.com *, [2] naniratnaningsih@unsil.ac.id , [2] pujilestari@unsil.ac.id
* evilatifa24@gmail.com .

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** Corresponding author.*

ABSTRACT: This research aimed to create an android-based learning media on solid figure materials to explore spatial abilities and to determine the quality of the effectiveness of students' spatial abilities after using these learning media. The research subjects included material experts, media experts, math teachers, and 25 students from MTs Al-Ishlah Cihaurbeuti class VIII. This study employed Research and Development with the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) development model. Data collection techniques in this study were observation, unstructured interviews, tests and questionnaires. This research resulted in an android-based learning media in the form of an application (.apk) on solid figure material to explore spatial abilities and was in a valid category very acceptable for utilization by junior high school students. As seen by the calculation of Effect Size, which yielded a value of 1.32 in the "strong effect" category, the resulting product is useful for exploring spatial abilities. This indicates that the learning media can be used as a learning resource to support mathematics learning in solid figure materials.
Keywords: Learning Media; Android; Spatial Ability.

Apakah media pembelajaran berbasis android efektif untuk mengeksplor kemampuan spasial siswa?

Abstrak: Penelitian ini bertujuan untuk menghasilkan media pembelajaran berbasis android pada materi bangun ruang untuk mengeksplor kemampuan spasial dan untuk mengetahui kualitas efektivitas kemampuan spasial siswa setelah menggunakan media pembelajaran tersebut. Subjek penelitian dalam penelitian ini yaitu ahli materi, ahli media, guru matematika dan 25 orang siswa MTs Al-Ishlah Cihaurbeuti kelas VIII. Metode penelitian yang digunakan yaitu R&D dengan model pengembangan *Analysis, Design, Development, Implementation, Evaluation* (ADDIE). Teknik pengumpulan data yang dilakukan dalam penelitian ini adalah observasi, wawancara tak terstruktur, tes dan angket. Sedangkan untuk instrumen yang digunakan yaitu soal tes kemampuan spasial, lembar validasi ahli materi dan ahli media, angket respon siswa dan guru. Penelitian ini menghasilkan suatu media pembelejaran berbasis android yang dikemas dalam bentuk aplikasi (.apk) pada materi bangun ruang untuk mengeksplor kemampuan spasial dan berada pada kategori valid sangat layak digunakan untuk siswa SMP. Produk yang dihasilkan efektif untuk mengeksplor kemampuan spasial terlihat dari hasil perhitungan *Effect Size* dengan nilai sebesar 1.32 dengan kategori "*strong effect*". Hal ini berarti media pembelajaran dapat digunakan sebagai sumber belajar pendukung pembelajaran matematika materi bangun ruang.

Kata Kunci: Media Pembelajaran; Android; Kemampuan Spasial.

INTRODUCTION

Given the current situation, the outbreak of a disease caused by the corona virus, also known as covid-19, shook the world. COVID-19 is spreading so quickly that state officials, especially Indonesian leaders, have employed social distance as a policy to prevent it. The

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policy had an impact on all parts of life, including education. The traditional learning method in schools is now being shifted to online learning at home or online learning (online learning).

According to Ratnaningsih, Ni'mah, and Hidayat (2021), the adoption of the online learning system has various challenges, including teacher and student facilities and infrastructure, as well as internet network constraints. According to Sirri & Lestari (2020), in online learning, teachers are required to employ existing technology, but not limited to giving assignments via social media; however, learning objectives must be met through innovation. According to NCTM (2000), the objective of learning mathematics is to increase thinking, connection, communication, problem-solving, and representation skills. In addition to these five abilities, spatial ability is one of the abilities that can be measured in studying mathematics, according to Subroto (2012). For many daily activities such as orientation, map reading, and computer activities such as altering text utilizing spreadsheets, maps, and computer information, spatial ability is regarded a very crucial ability (Pak, Chaya, Sharit, Rogers & Fisk, 2008). Students with excellent spatial ability are much more proficient in mathematics, according to Hannafin, Truxaw, Jennifer, and Yingjie (2008).

Spatial ability, according to Khine (2017), is the ability to process spatial thinking. Mathematical spatial ability, according to Lestari & Yudhanegara (2015), is the ability to envision, compare, guess, determine, construct, depict, and determine information from visual inputs in the context of geometry. Linn & Petersen (in Sudirman & Alghadari, 2020) claim that spatial ability is the ability to represent, transform, and retain symbolic information, which is in line with this. According to several of the aforementioned viewpoints, spatial ability is defined as the ability to represent, transform, and visualize solid figures.

According to Maier (1996), the indicator of spatial skill consists of five components: 1) Spatial Perception, which is the ability to determine the horizontal or vertical placement of an object being observed. 2) Spatial visualization is the ability to demonstrate the rules of change or displacement of constituent of a shape, either three-dimensional to two-dimensional or vice versa. 3) Mental rotation is the capacity to precisely and accurately rotate two-dimensional and three-dimensional objects. 4) Spatial Relations, or the ability to comprehend the layout of an object and its parts, as well as their interconnections. 5) Spatial Orientation is the ability to view a thing from different perspectives. According to Sirri, Ni'mah, and Ratnaningsih's (2021) research, both students with high and moderate learning independence have poor spatial abilities. There are still some students who find it difficult to determine a point to a line, a line to another line, a line to a plane (Wulansari and Adirakasiwi, 2019); and some students still struggle to imagine the shape of objects from various perspectives (Wulansari and Adirakasiwi, 2019). (Febriana, 2015).

The usage of learning media is one technique to help students overcome their learning obstacles. According to Yudha's (2019) opinion, students' learning obstacles can be overcome by using diverse media as mediators and sources for learning. Learning media are software and technology that teachers use to communicate and interact with students

during the learning process. It can be used in large groups, small groups, or individually (Kustandi and Darmawan, 2020). According to Wibawanto (2017), a challenge in the field is that many educators have been unable to optimize existing technology in order to actualize a curriculum that includes technology-based learning media such as computers and smartphones. Android-based learning media is one of the learning media that uses smartphones.

Based on Ratnaningsih, Nuradriani, and Nurazizah's (2021) research, android-based learning media received a favorable response and can be used by junior high school students. The Smart Apps Creator, according to Rachman (2019), is one of the platforms that can be used to create android-based learning media (SAC). SAC was chosen as the software to create interactive teaching materials in this study for several reasons (SmartAppsCreator, 2020), including: 1) It does not require programming skills, so anyone can use it as a learning medium. 2) The application's output can be used on a variety of platforms, including Android, iOS, web, Microsoft, and others. 3) It can integrate animation into the application art design, which will be created depending on the needs of the end user and the developer's imagination. 4) Interactivity; 5) Supports a wide range of file formats, including mp3, mp4, png, jpg, gif, pdf, insert webpage, map, and real-time test; 6) Integrated online services, which improves the application's functionality; and so on.

Several earlier studies (Komariah, Suhendri, & Hakim, 2018; A'yun & Rahmawati, 2018; Novitasari, Indrawati, & Risfianty, 2018; Dwiranata, Pramita, & Syaharuddin, 2019; Apriyanto & Hilmi, 2019; Nisa & Muniri, 2020) have created valid, practical, and reliable android-based learning However, no research on spatial skills has been identified, and the advancements of these media are confined to testing students' comprehension, therefore the researchers performed a study to construct android-based learning media on solid figure materials to explore students' spatial abilities.

METHOD

a. Type of research

Research & Development (R & D) method was employed in this study, which is research oriented to research, develop, produce, and test the validity of the resulting product (Sugiyono, 2016). The ADDIE (Analysis-Design-Development-Implementation-Evaluation) model developed by Branch(2009) was employed in this investigation.

b. Time and Place of Research

This research was conducted in class VIII-A Mts Al-Ishlah Cihaurbeuti which is located at Jl. Raya Cihaurbeuti No.02, Cihaurbeuti, Ciamis. The research was carried out from April 21, 2021 to August 9, 2021.

c. Research subject

As many as 25 students from class VIII-A of MTs Al-Ishlah Cihaurbeuti as subjects for product implementation, filling out spatial ability tests and filling out response questionnaires to the media. The research subjects were chosen based on the following criteria: a) Students with Android smartphones; b) Students with appropriate time; c) Students who can express themselves both orally and in writing.

d. Development Procedure

The development procedure of "Android-Based Learning Media on Solid figure materials to Explore Spatial Ability" includes the following stages:

1) Analysis stage, at this stage the researcher collects information by observing assignments and student learning outcomes, distributing questionnaires to analyze students' and teachers' demands on learning media, and thereafter conducting unstructured interviews.
2) Design Phase: This stage is carried out to assist researchers in designing learning media. This stage consists of the following steps: (a) gathering data in the form of material determined during the analysis stage, practice questions based on the material, quiz questions, and supporting images for the aesthetics of learning media, (b) creating flowcharts, and (c) creating storyboards.
3) Development stage, this is the stage in which what was created in the design stage is realized as a product in the form of an application. The created media is then validated by media and material experts before being implemented/tested on users. Following the expert test, the researcher revised the product until it was ready for implementation.
4) Implementation stage, this stage involves the validation of android-based learning media with small and large groups of users.
5) Evaluation stage, At this stage, the researcher administers a pretest-posttest of spatial abilities to students who have studied using android-based learning media in order to collect the data needed to calculate the effect size.

e. Data Collection Techniques and Research Instruments

The study's data collection techniques included interviews, tests, questionnaires, and observations. The instrument used is a spatial ability test with five essay questions, a validation questionnaire of material and media experts, and a questionnaire for teacher and student responses.

f. Data analysis technique

Data analysis was carried out by describing each ADDIE stage and calculating the effectiveness test.

RESULTS AND DISCUSSION

This research and development was conducted at MTs Al-Ishlah Cihaurbeuti class VIII to determine the feasibility and effectiveness of android-based learning media on solid figure materials for exploring spatial abilities. *Bangsidakung* is an android-based learning media (application) that is the primary outcome of this research and development (Solid figure on the Flat Side and the Curved Side). This research and development was carried out with the aid of ADDIE development, which included five stages: analysis, design,

development, implementation, and evaluation. The outcomes of each stage of the research process are shown below:

1) Analysis stage

At this point, interviews confirmed the findings from the teacher needs analysis questionnaire that the only learning resources used by students in schools were student's working book (LKS) in the form of SMP/MTs mathematics learning modules published by Sinar Mandiri. The lecture method is used because, according to the teacher, the students' learning hours in class are very limited, making teachers hesitant to use other methods. This, however, results in a lack of student interest in learning mathematics as well as a lack of student comprehension of mathematical material.

According to the results of observations, researchers found that the solid figure material is one of the materials with low learning outcomes. Solid figure material is closely related to spatial ability, this is in line with National Council Of Teachers Of Mathematics (Siswanto & Kusumah, 2017) which stated that one of the criteria given to geometry in schools is increasing student's visualization abilities, spatial abilities, and geometric modeling to solve problems.

The students were then given a needs analysis questionnaire by the researcher. Researchers did an experiment and discovered that students were interested in learning how to use android-based learning media. This is due to the fact that learning media in the form of an android application makes it easier for students to learn; additionally, the application contains a combination of audio, image, and video, distinguishing this android-based learning media from commonly used learning media. The use of android-based learning media is also consistent with the characteristics of current learning, in which learning is done online, so that 98 percent of students have and can effectively use smartphones.

2) Design stage

At this point, the researcher gathers the required supplies, including spatial ability test questions, material expert and media expert validation questionnaires, teacher and student response questionnaires, as well as practice questions and quizzes with discussions based on basic competencies and indicators of spatial ability. Following that, the researcher created a flowchart and story board to use as a guide while creating learning media.

3) Development stage

The first step in this stage is to identify the application's components. Backgrounds, learning videos, animations, icons, and menu elements are examples of these components. Smart Apps Creator was used by the researcher to create an android-based learning media, which was backed by additional software such as PowerPoint365, Wingeom, Geogebra, Inshot, and VN.

The initial display or start page of the learning media will appear first while using the learning media. After a few seconds, this start page will switch to the main menu or home display, which is the title of the material in the learning medium (see Figure 1). Competence, material text, video material, sample questions, quizzes, and profiles are the six options

displayed in the main or home menu display. When users of learning media wish to see the core and basic competencies of construction materials, they use the competency menu (see Figure 2).

Figure 1. *Start Page* and *Home*

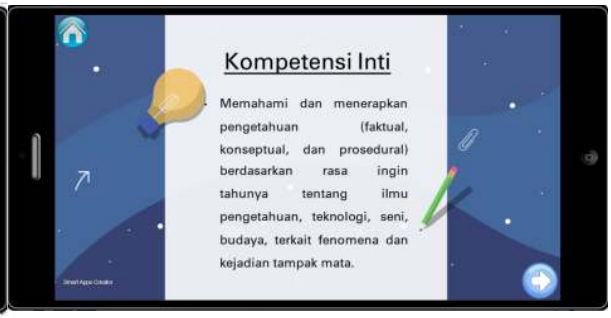

Figure 2. Competency Menu

When users of learning media desire to learn the subject, they select the "text material" menu. Each material includes an explanation of the elements, surface area and volume formulas, as well as the nets of solid figure (see Figure 3). Then there's the menu for "material video" (can be seen in Figure 4). It is more communicative because the explanation in the learning video is supported by a rotational solid figure and animation of solid figure nets.

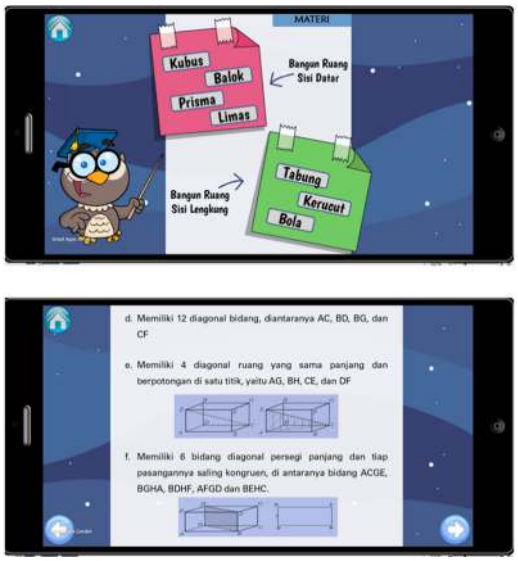

Figure 3. Material Text Menu

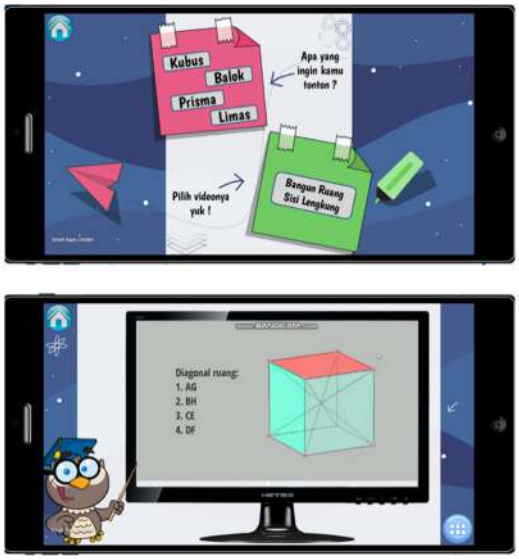

Figure 4. Material Video Menu

The "sample questions" menu contains sample questions and answers from previously studied content, such as spatial ability questions, with the goal of allowing users to progress from easy to harder questions. Figure 5 shows an example of a question menu display.

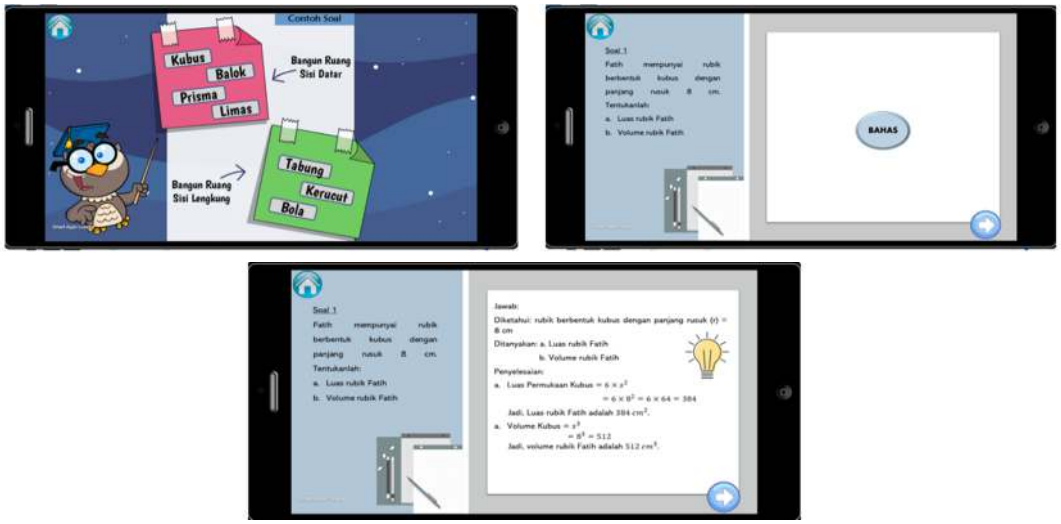

Figure 5. Sample Questions Menu

If a learner wants to evaluate their spatial abilities and comprehension of spatial information, they can use the "quiz" menu, which consists of ten multiple choice questions. At the end of each quiz session, the "quiz" menu includes a quiz question discussion option so that users can learn how to answer quiz questions.

Figure 6. Quiz Menu

Additionally, the "profile" menu offers brief information from Android-based learning media developers on solid figure materials for exploring spatial abilities.

After the learning media has been created, it is shown to material experts and media experts for evaluation and validation of the products that have been made in respective sectors. Validator 1 validated material experts for android-based learning media products on July 28, 2021, whereas validators II and III validated material experts on July 30, 2021. All

components of the evaluation were declared legitimate based on the opinions of three material expert validators. However, there are certain recommendations and insights regarding this android-based learning media, and the overall layout of construction elements in the learning media might be improved. Table 1 shows material experts' suggestions and results for improving learning media.

Table 1. Material Expert Validation

Suggestions for Improvement	Results of Improvement
1. An illustration of the diagonal of the space would be useful in explaining the cube of section e. 2. It is preferable to have an icon to bring up the discussion so that users are not disturbed by the appearance of answers in the sample questions. 3. Numbers should be used in sample questions. 4. Audio discussion of the example of cube number 2, it is better to explain the reason for using the cube root 3. 5. It is better to include an illustration on the example of prism question number 1.	1. There is an illustration image of the diagonal of the cube space on the "text material" menu. 2. There is a "discussion" icon to bring up the answers on the "sample questions" menu 3. Numbers in the sample of questions has been added. 4. Audio discussion of the example of cube number 2 has been improved. 5. There is an illustration in the example of prism number 1.

In addition, two media specialists assessed the practicality of android-based learning media before it was utilized in field testing. The findings of two media experts' evaluations in terms of layout, color combination, font size, text legibility, audio clarity, video display attractiveness, button placement, button functionality, and media practicality are accurate. The indicators for selecting a typeface and background sound are insufficient and should be enhanced. According to Raffiq, Qiram, and Rubiono (2017), many types of music influence the learning environment of students in the classroom. Spirit-themed music is a style of music that can trigger powerful and quick reactions. In general, android-based learning media on solid figure material can be utilized to increase spatial abilities.

4) Implementation stage

Researchers used individual and limited trials to determine how users reacted to the newly developed learning media. Individual trials were carried out on 5 eighth-grade students and three teachers. Based on the teacher's response questionnaire, a total score of 109 was obtained in the very good category. At this point, the teacher made some media-related comments and suggestions, including those made by the media expert validator regarding the application's excessive size and duplicate quiz scores. Other suggestions include improving the image's description to make it more clear, and using photos of

researchers and developers in the profile menu. While the student response questionnaire on individual trials yielded a total score of 140 in the "good" category. This is consistent with the findings of Zakiy, Syazali, and Farida (2018), who discovered that android-based learning media on plane figure materials received a positive response from students.

Limited trials on a larger scale, namely 20 students, were conducted. This trial resulted in a total score of 590 in the "good" category. The limited trial consisted of three meetings, the first of which the researcher explained about learning media and attempted to explore the menu of material texts, material videos, and examples of plane figure questions. During the second meeting, students looked at material texts, material videos, and examples of solid figure, as well as quizzes. The third meeting was devoted to post-test activities and the completion of student response questionnaires. A total of 65% students who were successful in installing learning media applications and only 35% used the HTML5 version, several students complained that the program was difficult to use because it was difficult to install.

5) Evaluation stage

The purpose of the evaluation stage was to determine the efficiency of spatial abilities after using android-based learning material. The pretest and posttest results are used to develop this efficacy test. The Effect Size of students' spatial abilities after using learning media is calculated as follows.:

- *Mean of posttest* = 0,67
- *Mean of pretest* = 1,43
- *Standard deviation of pretest* = 0,58

$$ES = \frac{mean\ of\ posttest - mean\ of\ pretest}{standard\ deviation\ of\ pretest}$$

$$ES = \frac{1{,}43 - 0{,}67}{0{,}58}$$

$$ES = 1{,}32$$

Based on the results of the effectiveness test, an Effect Size value of 1.32 was obtained with the interpretation of "strong effect" namely 1.32> 1.00 referring to the interpretation of Cohen, Manion, and Marrison (2007). Based on the effectiveness test results, an Effect Size value of 1.32 was obtained with the interpretation of "strong effect," namely 1.32> 1.00, according to Cohen, Manion, and Marrison's interpretation (2007). Because of the current learning material used in the form of applications, available learning videos, and sample questions and discussions, students' spatial ability is highly effective. According to Resti & Jaslin (2016), android-based learning media can improve learning motivation and make learning more fascinating and fun, as well as have an impact on enhancing learning outcomes. Furthermore, the sample questions offered in the media are not only limited to the showing of basic competencies, but also include spatial ability questions and solutions. There are additional representations of forms that can be rotated (dynamically) and the construction of nets in the learning video to help pupils with visualization. According to

Jaelani & Ahmad (2015), training on solving spatial ability issues and learning utilizing dynamic geometry software can help students enhance their spatial abilities. This is what can help students improve their spatial ability.

CONCLUSION

According to the assessments of material experts and media experts, Android-based learning media on solid figure materials to investigate spatial abilities that were developed utilizing ADDIE development are valid and appropriate for application. Based on the findings of individual trials and limited trials, teachers and students' reactions to learning media were categorized as very good and good. With the "strong effects" criteria, the quality of the effectiveness of students' spatial ability after using android-based learning media on solid figure material is 1.32, indicating that learning media is used effectively in learning.

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