

## **Android Learning Media Development to Improve Spatial Ability**

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### **Abstract**

The research aims to produce an interactive learning media. This research is included in the type of development research, using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The software used in this interactive learning media is Adobe Flash CS 6 and Unity as the main software. The research was carried out at SMP Muhammadiyah 7 Yogyakarta with the subject of 31 students of class VIII C in the 2020/2021 academic year. The research data was obtained from the results of material validation questionnaires by material experts, media validation questionnaires by media experts, and student response questionnaires by students. The feasibility of this interactive learning media is obtained from the process of quantitative and qualitative data analysis. The product of this development research is in the form of mathematics learning software for class VIII that can be downloaded and operated on android-based mobile phones. Based on the results by material experts, media experts, and students, this product obtained an average feasibility score of 77; 118.5; and 78.87 with very good, very good, and good qualitative categories. Thus, the interactive learning media product that has been successfully developed is suitable for use in the mathematics learning process.

**Keywords:** Learning Media, Unity, Solid Geometry.

## **Pengembangan Media Pembelajaran Android Untuk Meningkatkan Kemampuan Spasial**

### **Abstrak**

Penelitian bertujuan untuk untuk menghasilkan suatu produk media pembelajaran interaktif. Penelitian ini termasuk dalam jenis penelitian pengembangan, dengan menggunakan model pengembangan ADDIE (*Analysis, Design, Development, Implementation, and Evaluation*). *Software* yang dalam pembuatan media pembelajaran interaktif ini adalah *Adobe Flash CS 6* dan *Unity* sebagai *software* utamanya. Penelitian dilaksanakan di SMP Muhammadiyah 7 Yogyakarta dengan subjek 31 siswa kelas VIII C tahun pelajaran 2020/2021. Data penelitian diperoleh dari hasil angket validasi materi oleh ahli materi, angket validasi media oleh ahli media, dan angket respon siswa oleh siswa. Kelayakan media pembelajaran interaktif ini didapatkan dari proses analisis data secara kuantitatif dan kualitatif. Produk

hasil dari penelitian pengembangan ini berupa *software* pembelajaran matematika pada materi bangun ruang sisi datar kelas VIII yang dapat diunduh dan dioperasikan di ponsel berbasis *android*. Berdasarkan hasil uji coba oleh ahli materi, ahli media, dan uji pengguna, produk ini memperoleh rata-rata skor kelayakan berturut-turut 77; 118,5; dan 78,87 dengan kategori kualitatif sangat baik, sangat baik, dan baik. Dengan demikian, produk media pembelajaran interaktif yang telah berhasil dikembangkan ini layak digunakan dalam proses pembelajaran matematika.

**Kata kunci:** Media Pembelajaran, *Unity*, Bangun Ruang Sisi Datar.

## INTRODUCTION

Human life is something that runs dynamically. Everything will always evolve, including science and information technology. The development of science is basically always related or even manifested from various branches of mathematical science, such as: algebra, numbers, geometry, and statistics. It is no exaggeration if mathematics has been and has always been taught to students from the lowest level of education to higher education levels. Moreover, mathematics also presents problems that are contextual or commonly encountered and experienced by students in real life, as stated by Hernowo (Munaka, 2017), so that human life cannot be separated from mathematics.

According to Suyatno (2009:2) many students think that mathematics is the most difficult field of study and is rarely of interest, even though mathematics should not be something difficult. Students find it difficult to understand mathematics learning, in relation to doing abstractions with things that exist in the real world. According to Sirait (2016) an unsteady understanding will result in students having difficulty in solving questions, in other words, students do not understand the concepts contained in the material.

Geometry of space is one of the materials that comes from one of the branches of mathematics, namely geometry. In geometry, there are many elements that students must understand the concept of; point, line, plane and space. Each element also has a size, nature, and the relationship between one another. According to Iswadji (2003: 1) abstract geometric shapes are thought objects that have perfect shapes and sizes. The existence of a geometric context in the real world, of course, requires an abstraction, where abstraction cannot be done in one step at a time, so the ability of students to do abstraction must always be trained.

To facilitate the abstraction process, tools can help students to do the abstraction step by step. Spatial relationship is one of the aspects in the abstract concept of spatial ability (Tambunan, 2006).

There are two components that make up spatial ability, namely spatial visualization and spatial orientation. Sadiman (2007:2) defines learning media as all intermediaries that will convey information from the giver of information to the recipient of information in a learning process. Learning media serves to stimulate the thoughts, feelings, concerns and interests of learners so that the learning process can run well. To be able to improve students' spatial abilities, especially in geometry learning, a media that can help students build the arrangement of elements in a visual image can then be represented in two-dimensional space, by using Adobe Flash CS 6 and Unity.

Based on interviews with the Mathematics teacher of class VIII C and the distribution of questionnaires to class VIII C students conducted by researchers at SMP Muhammadiyah 7 Yogyakarta, the spatial ability of class VIII students is still low, especially in the material of building space where students are less able to try to develop their spatial sensing abilities that are very useful in understanding relations and properties in geometry to solve mathematical problems and problems in everyday life. In addition, mathematics learning is carried out using discussion and question and answer methods with teacher guidance (Discovery Learning), without using animated media or the like. The teacher provides material direction, then guides students to be able to find their own concepts from the material being given. And from the results of the questionnaire, it is known that the teaching materials needed are in the form of new, innovative, and interesting learning.

This research is different from the research on students' spatial ability that has been done. Previous research has only focused on students' ability in spatial geometry which cannot be separated from spatial ability because spatial ability is the ability to produce, store, retrieve and change well-structured three-dimensional images. This study focuses on developing a learning multimedia to improve students' spatial abilities in building spaces using Adobe Flash CS 6 and Unity.

Adobe Flash CS 6 and Unity are taken as interactive applications that can be used to create simple animation media that can support students' spatial visualization orientation skills on flat-sided geometry, which includes cubes, blocks, prisms, and pyramids. Adobe Flash CS 6 combined with Unity can be used to create animated media that can be operated on Android, so that students can easily and flexibly operate anywhere and anytime, so that No learning can be done anytime and anywhere. Programs made with Adobe Flash CS 6 and Unity can be used to create games, animations, presentations, videos, tutorials, and so on.

With the use of this application, students are expected to be easier to do abstraction. Based on data from the Education Research Center of the Ministry of Education and Culture, the results of the 2019 national exam for SMP/MTS levels in the Yogyakarta area, the percentage of absorption of geometry material mastery on the Mathematics national exam, is quite low when compared to other materials such as numbers, algebra, and statistics (Puspendik Kemdikbud, 2019).

Table 1. Percentage of Students Who Answered Correctly UN SMP/MTS DIY Province 2018/2019 Academic Year

No.	Material	City/District.	Province	National
1.	Number	65,38	56,40	38,51
2.	Algebra	72,10	64,63	50,88
<b>3.</b>	<b>Geometry and Measurement</b>	<b>65,03</b>	<b>56,11</b>	<b>41,80</b>
4.	Statistics and Opportunities	76,18	70,16	56,54

(Puspendik Kemdikbud, 2019)

In table 1, it is shown that the percentage of absorption in the mastery of geometry material on the Mathematics national exam is quite low when compared to other materials, where the national average is 41.80. This value is only better than the average value for the number material. Thus, the purpose of this research is to develop interactive learning media using Adobe Flash CS 6 and Unity. With this application that can be operated on an android smartphone, it is hoped that it can facilitate and motivate students in abstracting and consolidating concepts in building materials, especially flat-sided spaces. In addition, this learning media can be an additional learning material, even an alternative for learning geometry for class VIII students.

## **RESEARCH METHODS**

This research is included in the type of research and development, using Research and Development (RnD). In this study, researchers used the Analysis-Design-Develop-Implement-Evaluate (ADDIE) model. The ADDIE model is a model that can be easily applied and used in a curriculum that teaches knowledge, skills, and attitudes (Cheung 2016:4). The trial will be held on March 25 and 26, 2021, online through the help of the Zoom Meeting application at SMP Muhammadiyah 7 Yogyakarta. The research subjects were 31 students of class VIII C SMP Muhammadiyah 7 Yogyakarta. The instruments used in this study were questionnaires, namely: interview guidelines, media expert assessment questionnaires, material expert assessment questionnaires, and student response questionnaires. Data collection techniques used in this study, namely: observation of learning activities in February 2020, interviews with Mathematics teachers to collect data on student activities and learning processes, and assessment questionnaires which will later be used in data analysis.

The data in this study were obtained from the results of the assessment of media experts, material experts, and student responses. The data obtained are qualitative data and quantitative data in order to determine the quality and feasibility of the developed learning media. The following data were obtained: the results of the media expert's assessment were obtained from a questionnaire for media experts which covered two aspects, namely the quality of graphics and display design. The grid of instruments used comes from the Ministry of National Education in 2008 with slight modifications by researchers; the results of the material expert assessment are obtained from a questionnaire for material experts which includes aspects of content feasibility, language feasibility, and presentation feasibility. The grid of instruments used is derived from the 2014 BSNP with slight modifications by the researcher; the results of the media expert's assessment were obtained from a questionnaire for media experts which included aspects of presentation feasibility, language feasibility, graphic feasibility, and benefits. The grid of instruments used comes from the Ministry of National Education in 2008 with slight modifications by researchers.

Assessment in qualitative form is converted into quantitative form with a Likert scale. According to Usman & Akbar (2011:65) the scoring guideline is as follows:

Table 2. Assessment Score Guidelines

No	Qualitative data	Score
1	SS (Strongly agree)	5
2	S (Agree)	4
3	CS (Just Agree)	3
4	KS (Disagree)	2
5	STS (Strongly Disagree)	1

After that, look for the average score from the data that has been obtained with the following formula:

$$\bar{x} = \frac{\sum x}{N}$$

Information :

$\bar{x}$  = average score

$\sum x$  = total score

N = number of validators/appraisers

From the average that has been obtained, the next step is to change the average score into a qualitative value. According to Widyoko (2009:238) the criteria for changing the average score are as follows:

Table 3. Classification of Total Rating

No	Formula	Classification
1	$x > \bar{x}_i + 1,8Sb_i$	(SB) Very good
2	$\bar{x}_i + 0,6 < x \leq \bar{x}_i + 1,8Sb_i$	(B) Well
3	$\bar{x}_i - 0,6 < x \leq \bar{x}_i + 0,6Sb_i$	(C) Enough
4	$\bar{x}_i - 1,8 < x \leq \bar{x}_i - 0,6Sb_i$	(K) Not enough
5	$x \leq \bar{x}_i - 1,8Sb_i$	(SK) Very less

$$\bar{x}_i = \frac{1}{2} (\text{ideal maximum score} + \text{ideal minimum score})$$

$$Sb_i = \frac{1}{6} (\text{ideal maximum score} - \text{ideal minimum score})$$

Information :

x = actual score

$\bar{x}_1$  = ideal average

$Sb_i$  = ideal standard deviation

Ideal maximum score = number of criteria items x highest score

Ideal minimum score = number of criteria items x lowest score

Assessment on the development of this media is determined with a minimum value of B (Good). So, if the average value of material experts, media experts, and the results of student responses is at least Good (B), and there is an increase in students' spatial abilities, the learning media is declared feasible to use. The indicator of spatial ability is that students have spatial intelligence in solving spatial problems, namely by means of each student being able to try to develop their spatial sensing abilities in understanding

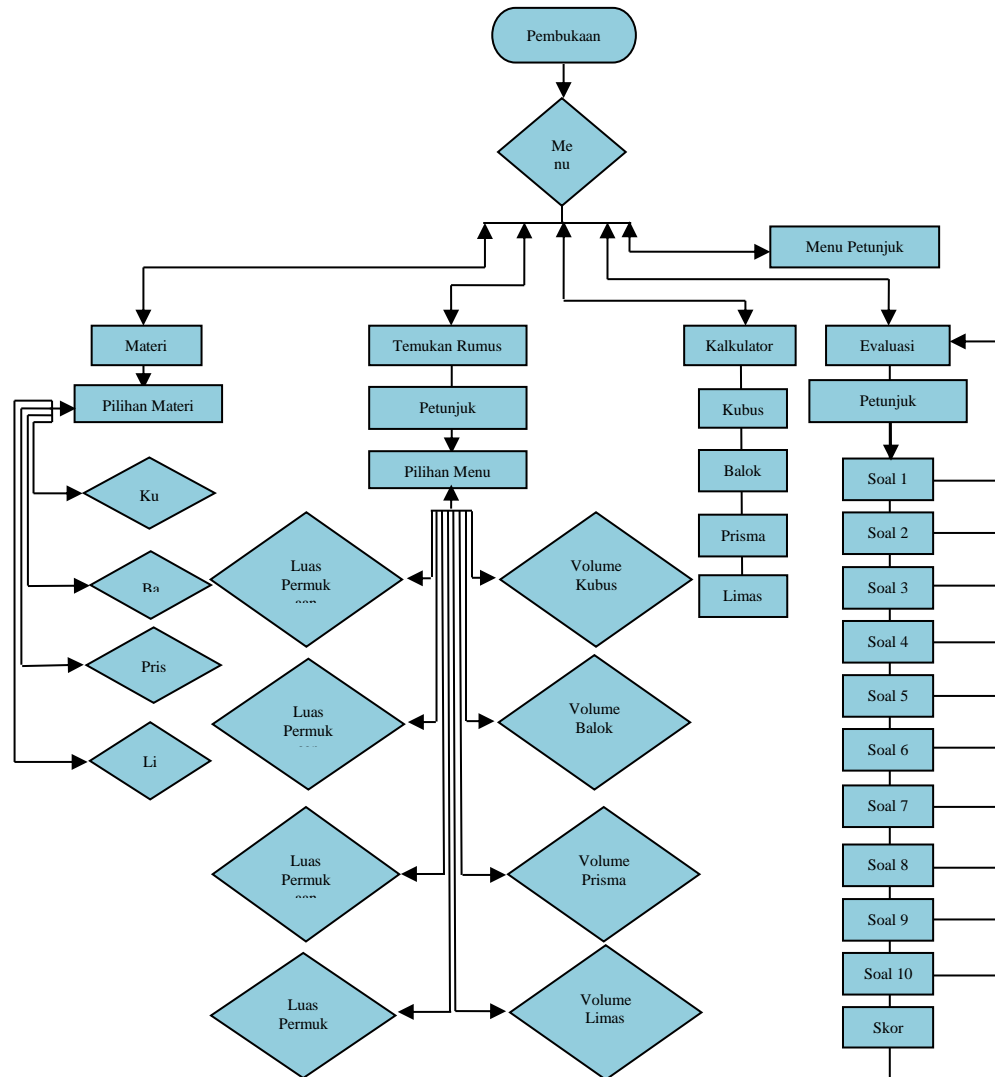
relations and properties in spatial shapes to solve mathematical problems in the form of questions and problems in everyday life. . Indicators can be broken down into; 1. Be able to analyze the characteristics and properties of two-dimensional and three-dimensional spatial structures and be able to explain mathematical arguments about the geometric relationship; 2. Be able to determine coordinates and describe spatial relationships in geometric coordinates and other representation systems; 3. Able to apply geometric transformations using basic coordinates (origin, axes, and angles) and symmetry to analyze mathematical situations; 4. use visualization, spatial reasoning, and geometric modeling skills to solve problems.

## **RESULTS AND DISCUSSION**

The learning media in the flat-sided building material was developed through 5 ADDIE stages. At the analysis stage, through the analysis of the needs of teaching materials that have been carried out by the researchers, it is known that learning mathematics in class VIII C SMP Muhammadiyah 7 Yogyakarta uses a guided discovery model and a question and answer method with students. In addition, there is no media that has been used in learning, so with the media used, it is hoped that it can create a new learning atmosphere and can help students understand the concept of flat side space.

The analysis of learning materials obtained by researchers from interviews with mathematics teachers in class VIII C of SMP Muhammadiyah 7 Yogyakarta and the distribution of questionnaires, stated that the material in class VIII was relatively difficult, where building a flat side space was one of them. In addition, students also agreed that android-based animation media would be developed on the flat-sided building material.

In the curriculum and situation analysis, SMP Muhammadiyah 7 Yogyakarta uses the latest curriculum 2013 curriculum. Unity was chosen by researchers as the main software and Adobe Flash CS 6 assistance to develop learning media, where developers (developers) can upload applications as a result of development, on Android-based smartphones. . After passing the analysis stage, the next stage is design. At this stage, the researcher first made a flowchart and storyboard. This is done in order to make it easier for researchers in compiling a display design that will be seen by users. The flowchart display to guide developing media is as follows.



**Figure 1.** *Media development flowchart*

Based on Figure 1 the flowchart compiled, when the learning media is opened, the first display seen is the opening, which displays the name of the learning media and a flat-sided image, equipped with a button to go to the main menu. In the main menu, several menus will be displayed, namely: materials, find formulas, calculators, and evaluations, as well as media instructions. The media guide menu contains the KI KD menu, the media usage guide menu, the sound settings menu, the developer profile menu, and the critique menu. The material menu contains material and discussion, as well as animations on flat-sided shapes, according to the selected sub-material. The Find Formulas menu is a menu that aims to help students find concepts in the flat-sided geometry material by finding their own formulas with questions and statements of assistance provided. The calculator menu is used to calculate the volume and surface area, according to the selected



submaterial. The last menu is the evaluation menu, where this menu contains score and time-limited evaluation questions that aim to hone students' abilities based on the material that has been studied in the flat-sided learning media.

The development stage is carried out by making learning media for flat-sided shapes using two software, namely Adobe Flash CS 6 and Unity as the main software.



**Figure 2.** Initial View

Figure 2 shows the initial display when the user opens the application, namely the appearance of the Ahmad Dahlan University logo. After that, the user will see an opening menu display that contains the name of the learning media as well as an image of the flat side shape, a menu of instructions, and a button that directs the user to the main menu.



**Figure 3.** Opening View

Figure 3. shows the instructions menu button located in the upper left corner of the opening menu, will open an instruction menu containing the KI KD menu, media usage instructions menu, sound settings menu, developer profile menu, and criticism suggestions menu.



**Figure 4.** Media Hint Display

Figure 4 shows the display of the media instructions containing the sound settings menu, developer profile and criticism suggestions menu. The KI KD menu contains KI, KD, and learning objectives on the flat-sided building material.



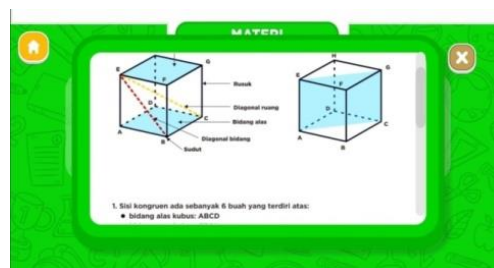
**Figure 5.** Display of KI, KD, and Learning Objectives

Figure 5 describes the main display on the learning media containing material, find formulas, calculators, and evaluations, as well as the menu for voice settings instructions, developer profiles, and criticism suggestions.



**Figure 6.** Material Menu Display

Figures 6 and 7 explain the menu of materials that contain material and discussion, as well as animations on flat-sided shapes, according to the selected sub-material.



**Figure 7.** Flat Side Room Build Material Display

The Find Formulas menu contains the menu for each flat side shape, along with their formulas.



Figure 8. Menu Display Find Formulas



Figure 9. Menu Display Define Volume Formula

Figures 8 and 9 show the find the formula menu which is a menu that aims to help students find concepts in the flat-sided wake-up material by finding their own formulas with questions and statements of assistance provided.



Figure 10. Calculator View

Figure 10 shows the calculator menu used to calculate the volume and surface area, according to the selected submaterial.



Figure 11. Evaluation Menu Display

Figure 11 shows the evaluation menu, where this menu contains a scored and time-limited evaluation question that aims to hone students' abilities based on the material that has been studied in the flat-sided wake-up learning media.

After the media design was successfully applied to the developed learning media, the researchers then validated the media to 2 media experts and 2 material experts. After the validation process from material experts and media experts has been approved, the researchers then carry out implementation through small class trial activities. This small class trial was attended by 5 students of class VIII C SMP Muhammadiyah 7 Yogyakarta who were randomly selected. The small class trial was carried out on March 25, 2021 online through the help of the Zoom Meeting application in connection with the Covid-19 pandemic. After that, students were asked to fill out a google form in the form of responses about learning media in order to make improvements before being tested in large classes. From the small class trial process carried out, no input was given by the students, so it was continued with the large class trial. The large class trial was held on March 26, 2021, through the help of the Zoom Meeting application. The trial of using learning media was attended by 31 students of class VIII C SMP Muhammadiyah 7 Yogyakarta. Then the 31 students were asked to fill out a student response questionnaire provided by the researcher in the form of a google form. Small class trials and large class trials are carried out in online classes using Zoom Meeting. The researcher directs students to install a flat-sided wake-up learning media application through the application link that is shared. Researchers check the suitability of the application display with students, thus ensuring that students actually install the application. After the application was installed on the student's android phone, the researcher gave directions and explanations about the learning media. Then the menus on the learning media were opened one by one together, where the researcher shared the application screen at the zoom meeting that was taking place, in order to make it easier for students to take part in the trial. During the researcher's presentation, students were always given the opportunity to ask questions about the menu and the contents of the menu on the flat-sided learning media.

The last stage in the ADDIE research model is evaluation. This stage is carried out to determine the assessment and feasibility of learning media that have been successfully developed. The calculation of the assessment was carried out based on the scores obtained

from the media expert questionnaire, the material expert questionnaire, and the student response questionnaire. The following are the results of the assessments of media experts, material experts, and student responses:

**Table 4.** Overall Results of the Calculation of the Media Expert Eligibility Questionnaire

No.	Aspect	Actual Score	Qualitative Classification
1.	Media Expert 1	122	Very good
2.	Media Expert 2	115	Very good
<b>Average Score</b>		118,5	Very good

**Table 5.** Result of Calculation of Media Expert Questionnaire Based on Aspect

No.	Aspect	Media Expert 1		Media Expert 2	
		Actual Score	Qualitative Classification	Actual Score	Qualitative Classification
1.	Graphic Quality	43	Very good	79	Very good
2.	Display Design	41	Very good	74	Very good

Based on tables 4 and 5, it can be seen that the average score of media expert eligibility is 118.5 with a very good qualitative classification. Where the feasibility score of media expert 1 is 122, with a very good qualitative classification and the feasibility score of media expert 2 is 115, with a very good qualitative classification. Thus, the learning media developed based on the media aspect is very good.

The average material expert feasibility score is 77 with a very good qualitative classification. Where the feasibility score of material expert 1 is 83, with a very good qualitative classification and the feasibility score of material expert 2 is 71, with a good qualitative classification. Thus, the learning media developed based on the material aspect is very good, it can be seen in tables 6 and 7 below;

**Table 6.** Overall Results of the Calculation of the Material Expert Feasibility Questionnaire

No.	Aspect	Actual Score	Qualitative Classification
1.	Material Expert 1	83	Very good
2.	Material Expert 2	71	Good
<b>Rata-rata Skor</b>		77	Very good

**Table 7.** Result of Calculation of Material Expert Questionnaire Based on Aspect

No.	Aspect	Media Expert 1		Media Expert 2	
		Actual Score	Qualitative Classification	Skor Aktual	Klasifikasi Kualitatif
1.	Content Eligibility	28	Very good	23	Good
2.	Language Eligibility	20	Very good	16	Good
3.	Appropriateness Presentation	35	Very good	32	Very good

**Table 8.** Result of Calculation of Student Response Questionnaire Based on Trial Sample

No.	Trial Sample	Actual Score	Qualitative Category
1.	Large Class Trial	78,87	Good

Based on table 8, it can be seen that the score of the student response questionnaire in the large class trial is 78.87 with a good qualitative category. Thus, the learning media developed based on student response questionnaires was good. The results of the calculation of student response questionnaires based on their aspects can be seen in table 9.

**Table 9.** Results of Calculation of Student Response Questionnaires on 4 Aspects

No.	Aspect	Large Class Trial	
		Actual Score	Qualitative Category
1.	Serving Eligibility	28,48	Good
2.	Language Eligibility	8,65	Very Good
3.	Graphic Eligibility	25,32	Very Good
4.	Benefits in spatial ability	16,42	Good

Based on table 9, it can be seen that the feasibility score based on aspects of the student response questionnaire is 28.48 for the presentation feasibility aspect, with a good qualitative category. 8.65 for the language feasibility aspect, with a very good qualitative category. 25.32 for the aspect of the feasibility of graphics, with a very good qualitative category. And 16.42 for aspects of benefits in improving students' spatial abilities, with good qualitative categories. The quality of the learning media developed was seen based on the assessments given by two media experts, two material experts, five students in the small class trial, and 31 students in the large class trial. If the average score from material

experts, media experts, and the results of student responses are at least good, then the learning media developed is declared feasible to use.

The media score in an effort to improve students' spatial ability was 16.42 with a good category. This condition is caused because the media is given examples of interesting images through technology and uses examples of concepts related to everyday life. This is in line with Nuraida and Amam (2019), who state that spatial abilities can develop effectively, through the use of technology-based media. The use of technology-based learning media such as Cabri 3D and GeoGebra can effectively improve students' spatial skills (Burte, Gardony, Hutton, & Taylor, 2017; Sack & Vazquez, 2011; Nurjanah, Latif, Yuliardi, & Tamur, 2020). Siti Faizah (Faizah, 2016) which states that in studying spatial geometry can not be separated from the spatial ability to be effective if it is associated with concepts that exist in everyday life to produce, store, retrieve and change well-structured three-dimensional images.

The spatial ability of junior high school students is closely related to the level of students' spatial geometry problem solving ability. This result is in line with the study conducted by Bishop (1980) in Rendik Widiyanto and Badiatur Rofiah (Widiyanto, 2012) which found a significant relationship between mathematical problem solving and students' visual spatial abilities. Biró (2015) states that there is a positive relationship between spatial intelligence, problem solving ability and mathematics learning achievement.

## **CONCLUSION**

This development research has succeeded in developing learning media on flat-sided geometrical materials using Adobe Flash CS 6 and Unity software technology and everyday concepts to grow spatial abilities relatively well. Media development according to the stages in the research model used, namely ADDIE. Referring to the research objectives, this learning media produces a product in the form of an application that can be operated on an android smartphone. Where learning media can facilitate and motivate students in abstracting and consolidating concepts on the material of building space, especially the flat side space. The feasibility of this interactive learning media is obtained from the process of quantitative and qualitative data analysis. The product of this development research is in the form of mathematics learning software for class VIII flat-

sided building materials that can be downloaded and operated on android-based mobile phones. Based on the results of trials by material experts, media experts, and user tests, this product obtained an average feasibility score of 77; 118.5; and 78.87 with very good, very good, and good qualitative categories. Thus, the interactive learning media product that has been successfully developed is suitable for use in the mathematics learning process.

From the development of this learning media, it is hoped that further research will continue to be able to improve the quality and increase the variety of the material developed. So that learning media is not only used in one material, but can be used continuously, adjusting the material being studied. In addition, researchers can add variations to the Operational System, so that learning media can be run on other OS, IOS for example.

## REFERENCES

- Biró, P., & Csernoch, M. (2015). The mathability of computer problem solving approaches. *2015 6th IEEE International Conference on Cognitive Infocommunications (CogInfoCom)*, 111–114.
- Burte, H., Gardony, A. L., Hutton, A., & Taylor, H. A. (2017). Think3d!: Improving mathematics learning through embodied spatial training. *Cognitive Research: Principles and Implications*, 2(1), 1–18. <https://doi.org/10.1186/s41235-017-0052-9>
- Faizah, S. (2016). Kemampuan Spasial Siswa Smp Dalam Memecahkan Masalah Geometri Ruang Berdasarkan Kecerdasan Spasial Dan Kecerdasan Logika. *Ed-Humanistics : Jurnal Ilmu Pendidikan*, 1, 62–72. <https://doi.org/10.33752/ed-humanistics.v1i1.18>
- Hamka, W.A. & Gani, A. (2016). Rancang Bangun Game Edukasi Berbasis Web dan Android Menggunakan Adobe Flash CS5 Action Script 3.0. *IJIS-Indonesian Journal On Information System*. 1(2).
- Jatiningsih, Paskalia Evi Sri. (2019). Pengembangan Media Pembelajaran Dalam Bentuk Aplikasi Logos Pada Mata Pelajaran Pendidikan Agama Katolik Kelas VIII di SMP Stella Duce 2 Yogyakarta. *Skripsi. Universitas Sanata Dharma*.
- Kurniawan, A., & Setiawan, D. (2019). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Smp Berbantuan Soal Kontekstual Pada Materi Bangun Ruang Sisi Datar. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 2(5), 271-282.



- Kustiyati, Nurul. (2016). Problematika Pembelajaran Matematika Materi Bangun. *Prosiding Konferensi Nasional Penelitian Matematika dan pembelajaran (KNPMP I)*.
- Munaka, F. (2017). *Meningkatkan Kemampuan Siswa Menyelesaikan Soal Kontekstual Melalui Cooperative Learning Di Kelas Viii 1 SMP Negeri 2 Pdamaran Oki*.
- Nuraida, I., & Amam, A. (2019). Hypothetical Learning Trajectory in Realistic Mathematics Education To Improve the Mathematical Communication of Junior High School Students. *Infinity Journal*, 8(2), 247. <https://doi.org/10.22460/infinity.v8i2.p247-258>
- Nurjanah, Latif, B., Yuliardi, R., & Tamur, M. (2020). Computer-assisted learning using the Cabri 3D for improving spatial ability and self-regulated learning. *Heliyon*, 6(July), e05536. <https://doi.org/10.1016/j.heliyon.2020.e05536>
- PeranginAngin, R. B., Panjaitan, S., Hutauruk, A., Manik, E., & Tambunan, H. (2021). Arah dan Trend Penelitian Pendidikan Matematika di Jurnal Riset Pendidikan Matematika (JRPM). *Vygotsky: Jurnal Pendidikan Matematika Dan Matematika*, 3(1), 49–62.
- Puspendik Kemdikbud. 2019. [https://hasilun.puspendik.kemdikbud.go.id/#2019!smp!daya\\_serap!04&02&999!T&03&T&T&1&!&1!&](https://hasilun.puspendik.kemdikbud.go.id/#2019!smp!daya_serap!04&02&999!T&03&T&T&1&!&1!&) diakses pada tanggal 08 Oktober 2020.
- Sack, J. & Vazquez, I. (2011). Development of a Learning Trajectory to Conceptualize. Conference: 35th Annual Conference of The, 1, 89–96.
- Sirait, E. D. (2016). Pengaruh minat belajar terhadap prestasi Belajar Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 6(1).
- Srisuganda, Maman. (2020). Pengembangan Media Pembelajaran Berbasis Augmented Reality pada Materi Bangun Ruang Sisi Datar untuk Peserta Didik Kelas VIII Semester Genap. Skripsi. Yogyakarta. Universitas Ahmad Dahlan
- Sudarman, O. H. (2015). Eksperimen Pembelajaran Matematika pada Bangun Ruang Sisi Lengkung dengan Menggunakan Pendekatan Realistic Mathematic Education Ditinjau dari Motivasi Belajar Siswa Kelas IX SMP Negeri 1 Colomadu Tahun Ajaran 2015/2016. Doctoral dissertation. Universitas Muhammadiyah Surakarta
- Supriyadi, S. (2016). ADOBE Flash Untuk Mendukung Pembelajaran. *Jurnal Komunikasi*. 7(2).
- Tambunan, S. M. (2006). Hubungan Antara Kemampuan Spasial Dengan Prestasi Belajar Matematika. *Makara Human Behavior Studies in Asia*, 10(1), 27. <https://doi.org/10.7454/mssh.v10i1.13>
- Wafa, Ahmad Khanif Ali & Syariful Fahmi. (2020). Pengembangan Media Pembelajaran Berbasis Android pada Materi Bangun Ruang Sisi Datar. *In UrbanGreen Conference Proceeding Library (Vol. 1, pp. 11-17)*.

Widiyanto, M. R. , & R. B. (n.d.). Pentingnya Kecerdasan Spasial dalam Pembelajaran Geometri. *EJurnal Universitas Slamet Riyadi*<https://ejurnal.unisri.ac.id> >.