

# Development of Macromedia Flash-Based Mathematics Learning Media Using Problem-Based Learning to Improve the Spatial Ability of PAB 2 Helvetia Vocational High School Students

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**Abstract:** This research aims to: (1) To determine the validity, effectiveness, and practicality of learning media assisted by Macromedia flash; (2) To find out whether macromedia flash-based learning media through the jigsaw type cooperative learning model can improve the mathematical spatial ability of 11th grade student of RPL at PAB 2 Helvetia Vocational High School Students. This research uses the Thiagarajan 4-D development model and the product in this research is Macromedia flash-assisted learning media on three-dimensional material. This research was conducted at PAB 2 Helvetia Vocational High School Student which is one of the vocational high schools in Deli Serdang Regency in the even semester of the 2019/2020 academic year on three-dimensional material. The subjects in this study were students of 11th grade student of RPL at PAB 2 Helvetia Vocational High School Students. The results of this study indicate that: (1) the developed learning media has met the valid, practical, and effective criteria; (2) mathematical spatial ability has increased after using Macromedia flash-based learning media.

**Keywords:** learning media, macromedia flash, jigsaw cooperative type, spatial ability

## 1. Introduction

The role of mathematics itself has the benefit of improving students' abilities and intelligence in solving problems in everyday life. This is in accordance with the understanding of mathematics according to Johansson, Helena (2015) [1] mathematics is a subject with many fields and consists of very different characters. Some of them are purely theoretical discoveries that can have applications, such as prime numbers that have many benefits for the daily life of modern humans. Johansson's statement is in line with the statement of Asis, M. Arsyad, N and Alimuddin (2015) [2]. The role of mathematics is considered to be a servant for other disciplines and can train higher-order thinking skills. Strong mastery of mathematics from an early age is needed to be able to master and create technology in the future (Franselaa, 2018) [3]. Based on this opinion, it can be said that mathematics affects other sciences because it is involved in human daily life. Geometry. It is one of the oldest branches of science. in mathematics. According to Arianto, Fuad and Hernadi, Julan (2016) [4]. Geometry is. a branch of mathematics. which contains the concept of points, lines, planes and objects of space and their properties. sizes,. between one another. In fact, in learning geometry students still find difficulties even though the geometry material has been taught starting from the level. elementary school education. until high school. above or equivalent. Thing. This is evidenced by research conducted by Sholihah. S. Z & Afriansyah, E. A. (2017) [5] which factors are the cause. Students' difficulties in quadrilateral material are caused by several things, namely a lack of understanding of the concepts and properties of quadrilaterals, a lack of prior understanding of the quadrilateral shape material, and a lack of skills in using geometric ideas in solving problems.

Mathematical problems related to quadrilaterals. and classroom conditions that are not conducive to learning. According to NCTM. (2000) [6], one of the standards it provides. geometry in school is in order for the child. can use visualization, have spatial reasoning skills and modeling geometry to solve problems. Geometry itself has a great opportunity to be easily understood by students because examples of geometry problems are obtained in a concrete way compared to other materials in mathematics. As said above, geometry is something related to space and in the education system in Indonesia, geometry of space is studied at the high school level under the name of Three Dimensional Space. According to Yurt, Eyüp and Tünkler, Vural (2016) [7]. To understand space, spatial abilities are needed. Based on this statement, in studying geometry material, spatial abilities are needed. Basic thinking about spatial. quite interesting to discuss considering a lot of research. found that child. find many difficulties in understanding objects or geometric shapes (Syahputra, Edi 2013) [8]. Barke and Engida (in Syahputra, Edi 2013) said the same thing, that spatial ability not only plays an important role in the success of mathematics and other lessons, but spatial ability also greatly influences various types of professions. National Academy. of Science (2006) [9] says that there are many fields of science that require spatial skills in their application, including astronomy, education, geography, geosciences, and psychology. In line with the above statement Lubinski, 2010; NRC, 2006 also stated that .spatial ability is a very ability. essential and fundamental to doing well in the departments of Science, Technology, Engineering, Mathematics, and Geography. Ayunda, T.R (2019) [10] stated that students' spatial abilities also affect biology learning outcomes, especially in biology learning. Yurt, (2014) [11] also said that spatial abilities are also needed in social studies as well as in spatial learning. Alias, Black, and Gray (2002) [12] state that in order to solve technical problems, good spatial skills are needed. Hannafin, Truxaw, Vermillion, & Liu, (2008) [13] the importance of spatial abilities in engineering and mathematics, especially geometry. Peng and Sollervall, (2014) [14] say that spatial ability will effectively continue to increase if in our daily lives; doing sports and placing our belongings

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regularly and while using the map. Narpila's (2015) [15] research results also state ability. YPK high school students spatial. Class X's field is still relatively low in spatial ability, it can be seen that only 15 people answered that only 15 people answered out of 38 students who took the test. That is, there are only 39.5. % of students who could solve the problem correctly, the rest answered incorrectly. In line with Juhara (2014) [16] who conducted research at SMA Negeri 4 Bandung out of 41 students in class XI who were given a written test on geometry material, only a small percentage of students answered correctly. Most other students still can't imagine three-dimensional objects, so students still can't find an implied message. contained in the question. According to Sinurat, Syahputra, and Rajagukguk (2015) [17] stated that current technological advances motivate teachers to deliver learning materials through interesting media. Learning to use multimedia aids that are interactive and support various aspects such as sound, video, animation, text, and graphics are more effective in facilitating students' spatial abilities. The same thing was also conveyed by Handayani, T.W (2019) [18] who said that using macromedia flash media can be used. produce quality programs because of the media produced. more variable. Based on this, macromedia has its own advantages when applied in mathematics learning. Liberna (2018) [19] states Macromedia flash is a professional standard writing tool application program. which is used to create amazing vector and bitmap animations to create interactive, attractive and dynamic websites. Nasution, N. Bornok and Muktar (2019) [20] that learning media assisted by Macromedia flash software using a discovery learning model can improve students' conceptual understanding and independent learning. Student activities in the learning process have met the criteria to achieve the set ideal percentage of time. Furthermore, the effectiveness of learning media in terms of student responses to components and learning activities using macromedia flash learning media applying the discovery model is positive. At the same time, Putri, J. H, Syahputra and Mulyono (2019) [21] The application of Macromedia flash in mathematics is effective if it is applied to solid geometry subjects (cube and cuboid) in junior high school. This proves that the use of Macromedia flash has a great influence on learning mathematics. Tamba (2011) [22] which states that the use of ICT in learning in SMK encounters several obstacles, so it is included in the low category. For Macromedia flash itself there are several problems including; Salim and Tiawa (2014) [23] The results of the analysis in the Department of Engineering Mathematics show that Macromedia flash learning is less attractive due to layout problems, material display and image problems as well as colors that are less harmonious or not in accordance with the background color in Macromedia flash animation. We can see that the use of Macromedia flash itself can have an impact on the results of learning mathematics, if in its manufacture it is not considered in detail about the color, location and material. This proves that the design of Macromedia flash must be considered in detail in order to improve students' mathematics learning. Problem-based learning model is a learning model that is based on the number of problems that require authentic investigation, namely investigations that require real solutions to real problems so that students get used to thinking divergently. Learning that starts with a problem will change learning that has been teacher-centered to become student-centered. As stated that the existence of a problem requires students to develop their mindset in solving the problem. In

addition, one of the goals of students being trained to solve problems using problem solving is to improve students' spatial abilities. The stages of the problem-based learning model according to Polya (Sumartini 2016: 152) [24] are (1). Understanding the problem (2). Plan the solution. (3). Solve problems according to plan. (4) Re-examine the procedure and the results of the settlement. Based on the results of the description of the thoughts above, it can be concluded that the use of interactive learning media in the mathematics learning process is very important to do through the development of PAB 2 Helvetia Vocational High School already has facilities and infrastructure such as: computer laboratory room, internet network with wifi facilities, with LCD projector, but teachers have not empowered these facilities and infrastructure to the fullest. This encourages the researcher's desire to develop learning media for class XI mathematics on the subject of assisted three-dimensional space. The technology uses Macromedia flash 8.0 software.

## 2. Methods

### Research Pattern

This research includes development research. This research uses the 4-D Thiagarajan development model and the product in this research is Macromedia flash-assisted learning media on three-dimensional material. This study used a limited trial to 15 students of 11th grade student of RPL at PAB 2 Helvetia Vocational High School. This is because Indonesia, especially the city of Deli Serdang, is facing the Covid-19 pandemic, so learning in schools is carried out in teams.

### Subject

The subjects in this study were students of 11th grade of RPL at PAB 2 Helvetia Vocational High School with the reason that the school distributed all students of class XI randomly, so it was assumed that the ability of students in each class was homogeneous.

### Instruments

To assess the learning media that have been developed, in this development research, the following data collection instruments were used:

### Questionnaire Sheets

Questionnaire sheets used in this study were questionnaire sheets for subject matter experts, questionnaire sheets for learning media experts, practicality questionnaire sheets for learning media for mathematics teachers and students, and questionnaires on the effectiveness of student learning media.

### Spatial Ability Test

A test is a tool or procedure used to find out or measure something in an atmosphere, in ways and rules that have been determined. This spatial ability test was conducted to measure the effectiveness of the developed learning media as well as to see the students' spatial abilities.

### Learning Media Development Procedure

According to Trianto (2011) [25] the 4D development model can be adapted into 4Ps, namely definition, design, development, and deployment. The application of the main steps in the study is not only based on the original version but

is adjusted to the characteristics of the subject and the place of origin of the examiner.

The 4D model was chosen because it is systematic and suitable for developing this Macromedia flash-assisted learning media, but in this study the researchers modified the 4D model. Modifications were made with the consideration that this model is used for all normal students and it is not possible to carry out all stages of the 4D model in detail due to limitations. The modified 4D model in this study was shown for normal students.

This research is divided into two stages. The first stage is the development of learning media assisted by Macromedia flash 8.0. The development of learning media includes the design of learning media, validation of the content of learning materials, and validation of learning media experts. The second stage in this research is to try out learning media assisted by Macromedia flash 8.0 in 11th grade student of RPL at PAB 2 Helvetia Vocational High School Students for the 2019/2020 school year. So that the results will be obtained from the research which will be discussed in the next chapter on the development of the media.

### 3. Results and Discussion

#### a) The Validity of the Development of Macromedia Flash-Assisted Mathematics Learning Media

Based on the results of the validation of the mathematics learning media assisted by Macromedia Flash that was developed, it was found that the mathematics learning media was declared valid or had a good degree of validity. Then the learning media based on Macromedia Flash that was developed was also said to be feasible based on all aspects of the validity of the learning media. Furthermore, the results of the validation of the learning implementation plan (RPP), student worksheets (LKPD), and spatial ability tests are also valid or have a good degree of validity. This shows that the learning media assisted by Macromedia Flash which was developed along with the lesson plans, LKPD, and spatial ability tests have met the criteria of validity.

The results of the assessment that the media developed were declared valid. For more details, consider the following table:

#### Learning Media Validation Results by Experts

Validator	Average Score	Percentage	Information
Learning Media Expert	3,84	86,1%	Very Valid
Learning Material Expert	3,34	83,6%	Very valid

#### b) Practicality of Macromedia Flash-Based Learning Media Development

In general, students' practicality questionnaires in trials 1 and 2 showed positive things. The assessment aspect of the student questionnaire is also the same as the teacher's questionnaire, namely the effective, interactive, interesting, efficient and creative aspects. This is done so that the assessment is truly objective. The results of the questionnaire dominant students chose that the learning media was much more interactive than ordinary learning so that students carried out more meaningful

learning, because they did learning by themselves and students' memory of the material was much longer. Students are also not difficult in interpreting the three-dimensional material presented by the teacher through learning media.

#### Description of Practicality By Teacher

Aspect	Average of Each Aspect	Total Average	Information
1. Effective Aspect	0,987		
2. Interactive Aspect	0,937		
3. Interesting Aspect	0,875	0.875	Very Practical
4. Efficient Aspect	0,833		
5. Creative Aspect	0,75		

Based on the table above, it can be seen that the four aspects that are the criteria for practicality have very practical practicality values and one of them (creative aspect) is in the practical category. If it is averaged in total, the practicality of learning media is categorized as "very practical" by the teacher.

#### Description of Practicality by Students on Trial I

Aspect	Average of Each Aspect	Total Average	Information
1. Effective Aspect	0,855		
2. Interactive Aspect	0,913		
3. Interesting Aspect	0,875	0.866	Very Practical
4. Efficient Aspect	0,811		
5. Creative Aspect	0,626		

Based on the two tables above as a whole, the results of the practicality analysis in the first trial show that the learning media developed fulfills all the practicality criteria set, namely the average practicality score  $\geq 76\%$ .

The results of the practicality questionnaire conducted by students in the second trial are as follows:

#### Description of Practicality by Students in Trial II

Aspect	Average of Each Aspect	Total Average	Information
1. Effective Aspect	0,85769		
2. Interactive Aspect	0,916		
3. Interesting Aspect	0,885	0.889	Very Practical
4. Efficient Aspect	0,822		
5. Creative Aspect	0,777		

Based on the table above, as in the first trial the creative aspect has the lowest value among the others, but the value of the creative aspect is 77.7% greater than the predetermined practicality criteria which is around 76%. Overall, the average practicality score by students was 0.889 or 88.9% with the very practical category exceeding the specified standard value of 0.76 or 76%. the results of teacher and student questionnaires regarding the practicality of learning media that have been described above, it can be concluded that Macromedia Flash-based learning media is a practical learning media.

#### c) The Effectiveness of Development of Macromedia Flash-Based Mathematics Learning Media

Based on the results of the special ability test analysis in trials I and II, it showed that students' spatial abilities increased. This increase in spatial ability can be seen from the average spatial ability test results obtained by students. The improvement of students' spatial ability is also seen in each aspect of spatial ability.

In the first trial, the students' spatial ability increased from 63 to 69 with low N-gain criteria. However, after the Macromedia Flash media was redesigned according to the suggestions and

evaluations in the first trial, it was found that in the second trial, the students' spatial abilities increased from 63 to 83 with moderate N-gain criteria. This shows that the use of assisted mathematics learning media or flash developed has an impact on increasing students' spatial abilities even though appropriate learning media are used in learning in 11th grade student of RPL at PAB 2 Helvetia Vocational High School from the results of student responses but in terms of improving students' special abilities the learning media is still categorized as quite provide an increase in spatial ability due to the lack of improvement in the ability of students to achieve at SMK PAB 2 Helvetia.

Likewise, it was stated in the 2013 study that the spatial ability of students who were taught using learning media was better than students who were taught without using learning media. school. This means that using learning media during the teaching and learning process can improve students' spatial abilities. One of the expert recommendations to be the main focus in improving the special abilities of Zulfahmi Syahputra and Fauzi (2017).

**Value of Student Ability Based on Aspect**

Spatial Aspect	Trial I		Trial II			
	Pre test	Pos Test	Pre test	Pos Test		
Spatial Perception	63,3	78,3	15	63,6	81,6	18,3
Visualitation	76,6	73,3	-3,3	76,6	93,3	16,7
Mental Rotation	56,6	65	8,4	56,6	76,6	20
Spatial Relation	65	75	10	66,6	83,3	16,7
Spatial Orientation	53,3	53,3	0	53,3	80	26,7

In this study, in trial 1 the average value of the Spatial Orientation aspect did not increase, while in trial II it increased by 26,7.

#### 4. Conclusions

The validation of the learning media based on Macromedia Flash that was developed was in the "Very Valid" category in terms of the analysis of the results of the validity of the learning media by the validators with a total average value of 3,59. The learning media based on Macromedia Flash that was developed met the criteria for the practicality of learning media in terms of teacher and student questionnaires. The teacher's questionnaire in the "Very Practical" category with a value of 0,875, while the student questionnaire in the first and second trials also scored "Very Practical" with an average value of 0,866 and 0,889. So that the learning media developed successfully meets the criteria for the practicality of learning media. And the developed learning media has met the established effectiveness criteria. In the first trial the classical mastery spatial mathematical ability of students was 60% (9 students) and in the second trial it was 93,3% (14 students). The average student response score was 3,25 (81,3%) in the "Positive" category in the first trial and 3,56 (88%) in the "Positive" category in the second trial. The average achievement of Learning Time using Macromedia Flash is the same as normal learning time, so the learning media can be said to be effective.

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