

Developing Mathematics Learning Media Based on Macromedia Flash by Using Problem-Based Learning to Improve Students' Mathematical Spatial Ability

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Abstract This research was aimed to know the validity, effectiveness and practicality of Macromedia Flash development in learning media so that it can improve the students' spatial ability. This research subject was eighth grade students of SMP Negeri 1 Batang Kuis 2019/2020. This research object was Macromedia Flash application in Mathematic subject of solid geometry (cube and cuboids) using Problem-Based Learning. This research instrument was testing the spatial ability. This is a development research which used 4-D development model. The result of this research is valid known from the learning media validity score with the average of 4.55 from the media expert and 4.64 from learning material expert, then the validity score total of lesson plan is 4.48; worksheet is 4.62; the spatial ability test and Mathematic learning motivation survey are also valid. The mathematic learning media which was developed is effective, known from students' learning mastery calcically reached 91.99%. The improving of students' spatial ability used learning media which was developed on solid geometry subject (cube and cuboids), shows the increasing in average score from 67.93 to 84.13 .The average score of each spatial ability indicator is also increasing.

Keywords: *macromedia flash, problem based learning, spatial ability*

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1. Introduction

Education is needed by every human. Without education human will be difficult to develop and even will be retarded. One of the problem which faced by education field in Indonesia is the lack of learning process. Many ways have been done to improve the education quality of Indonesia. But, the education quality indicator has not improved significantly. One of the ways to improve the education field in Indonesia is improving the learning process, so there should be improvement in learning process based on the development era which require the students' broad insight.

One of the important lessons in education is mathematic, because mathematic is one of the main knowledge and it has role in completing the other knowledge. Therefore, mathematic is becoming one of the indicator of Indonesian's education quality so that there are many ways to improve mathematic lessons. Besides that, mathematic is a universal knowledge which becomes the basic of modern technology development and has important role in much knowledge to enhance human thinking in mastering and creating future technology. All of those aspects can be achieved by mastering mathematic since a child.

In fact, students have difficulties in learning mathematic, because mathematic is a lesson which contains abstract things so that it is difficult to understand and boring, mathematic also only learn about numbers. Besides that, the lack of students' role in learning process caused the students do not have interest to learn mathematic, because students only accept knowledge from teachers.

[1] stated that mathematic taught at school in junior high school grade covers four branches, those are geometry, algebra, numbers, statistic and opportunity. In Indonesia the importance of geometry can be seen in curriculum proportion, it is about 42 % of material taught. Geometry is also a lesson which is learnt from elementary school until university and geometry is one of mathematic branches because geometry material is the key to understand nature in this world. According to [2], based on psychology point of view, geometry is an abstraction presentation from visual and spatial experience, for example areas, pattern, measurement and mapping. Geometry does not only develop students' cognitive ability but also shape the students' memory from concrete become abstract. Based on that opinion, geometry is becoming an important material in learning mathematic.

[3] stated that based on psychology point of view, geometry is an abstraction presentation from visual and spatial experience, for example areas, pattern, measurement

and mapping. Therefore, that is clear that spatial ability plays an important role in geometry lesson. Spatial ability according to [4] is (1) perception ability to catch and understand something from five senses, (2) eyes ability especially colors and space, (3) transformation ability to switch over things which are caught by eyes to the other form, for example observing, recording, interpreting in mind and transfer it to picture, sketch, and collage.

While based on [5] opinion, spatial ability is an abstract concept which contains spatial relationship (ability to observe the relationship of object in a space), reference framework (sign used to decide the object position in a space), projective relationship (ability to see objects from some point of views), distance conservation (ability to estimate distance between two points), spatial representation (ability to represent spatial relationship by manipulating cognitively), mental rotation (imagine objects rotation in a space).

According to [4], one of standard why geometry lesson given in schools is to make students using visualization, having spatial ability and geometry model to solve problems. This is because geometry ideas have been known by students since they have not been at school yet, for example, line, areas, and space. Although geometry is being taught, in fact, the results show that geometry material is not mastered by most of the students. There are still many students feel difficult in learning geometry, especially in junior high school level.

Based on the spatial ability meaning, this ability needs a high level of thinking in observing spatial world and imagine geometry shape, because it needs a high level of imagination. Spatial ability also needs left-right understanding, perspective understanding, relates spatial concept with numbers, ability in transforming mental from visual shadow which is a brain work. It is so important for students to have this spatial ability, so that teachers are required to pay attention on this ability in learning process at classroom. But, the spatial ability which is owned by students is still lack.

Therefore, it needs an appropriate learning activity to improve students' spatial ability, for example by using Macromedia Flash as a learning media to describe geometry shapes in real context, so that, students will be easier to understand it, not only understanding the routine things. [4] said that students' spatial ability which was taught using learning media will be better compare to the students taught without learning media. Studying used multimedia made students more active, made the communication more effective, facilitated forum and added studying interest and motivation.

But nowadays there are still many teachers who do not give attention to learning media, so that the teachers should be forced to develop and use learning media in order to improve learning quality in the class, because learning media gives contribution in improving learning quality. Developing learning media needs to be done by teachers to solve the lack of existence of media itself. Hamalik stated that teachers are required to be able to use tools given by schools, and the tools should be based on the development of era.

In this research, researcher used Macromedia Flash 8 as the media in teaching and learning process. It is because Macromedia Flash 8 is one of software which can serve

audiovisual message clearly to the students and the material is real, so that it can be illustrated interestingly to the students using some animations pictures which can improve the students' learning interest to reach learning goals.

Developing learning media with Macromedia Flash application can be used to create an interesting learning media and the result will be efficient. The using of Macromedia Flash in learning process has been done by many researches or teachers. [6] about developing cell learning media using Macromedia Flash for senior high school grade XII proved that students' learning result using this media was higher compared to the students who learnt without media. From that explanation, it is seen that using learning media with Macromedia Flash was proved improving mathematic students' learning ability.

According to [7] Macromedia Flash 8 is a movie file animation. Movie created can be a graphic or text. Graphic meant here is vector graphic. So, when it is accessed by internet, the animation will be faster and softer. Besides that, Macromedia Flash can also import audio, video, or picture file from other application. Besides using for making website animation, Macromedia Flash can also be used to make game, presentation and cartoon animation.

Researcher also sees that developing media based on Macromedia Flash for every material is an appropriate alternative in teaching and learning process. Because teachers only use text book as the media, so using the media completed with interesting animation pictures and execution button can make teaching and learning process become interesting and not monotone, and also can be easily understood.

Using learning media in learning mathematic will also help improving students' mathematic ability, one of them is students' spatial ability. [8] from his research results in *Journal of Learning and Individual Differences* stated that there is strong relationship between spatial ability with mathematic geometry learning results and bad spatial ability influences students' mathematic worry. The same thing is also stated by [10] that a good spatial ability supports students' mathematic achievement especially in technology topic, science and engine. Based on those explanations, it can be concluded that to improve mathematic learning result especially geometry, spatial ability, the ability related to areas, pictures, and visual aspects should be improved.

When teaching geometry, most of teachers gave information about the amount of side, area, wide, and others which made students memorized it. Spatial ability is an ability to think on shape, composition, and the changing of an object in a space when turned, moved, or seen on different point of view [9]. Whereas, the main components in spatial thought are spatial perception, spatial visualization, spatial orientation, spatial rotation, and spatial relation [11]. One of the alternatives to improve spatial ability is using mathematic learning media. There are many medias which can be used, one of them is Macromedia Flash program.

Learning strategy used by teachers will be depend on the approach used while how to run the strategy can use some learning methods [12]. The choosing methods, strategies, models or approaches should pay attention to the learning goals. So that, the learning goals can be achieved.

Problem-Based learning model made the students think divergently. Problem can forced students to develop their mind in solving the problem itself. Besides that, one of the purpose why students trained to solve problem using the problem solving is improving students' spatial ability.

Problem-Based learning steps used in learning process can be divided to some phases: 1) Orientation phase, oriented students to the real problem; 2) Engagement phase, students are taking part in problem solving; 3) Inquiry and Investigation, students do research and investigation in order to solve the problem; 4) Debriefing, students discuss about the problem solving done [6].

2. Research Method

This is a development research which used 4-D development model. This research was done in eight grade of SMP Negeri 1 Batang Kuis 2019/2020. The research was done on August 2019. The research subject was eight students of SMP Negeri 1 Batang Kuis 2019/2020. The research object was Learning media application (Macromedia Flash) on solid geometry (cube and cuboids) using Problem-Based learning model.

This research was based on the model developed by [10] which consist of 4 main steps, define, design, develop, and disseminate or adapted become 4-D.

3. Result and Discussions

3.1. The Validity of Mathematic Learning Media Based on Macromedia Flash which Developed

Learning media validation from media expert is 4.55 and from learning expert is 4.64. Lesson plan validation is 4.48. Worksheet validation is 4.62. Spatial ability test reliability is 0.7028 (high category). Spatial ability test research instrument for 2 essay questions $r_{count} = 17.198$ and $r_{count} = 9.102$ with significant level 5%, reached $r_{table} = 2.030$. if it refers to testing criteria, with testing criteria $r_{count} > r_{table}$, so spatial ability test can be used or valid.

3.2. The Assessment from Expert on Mathematic Learning Media Based on Macromedia Flash in First Trial

Table 1. Learning Media Validation Results from Experts

Validator	Average score	Criteria
Mathematic Learning Media Expert	4,55	Valid
Mathematic Learning Material Expert	4,64	Valid

By counting using learning media feasibility formula above, the results are as follow:

Table 2. Learning Media Feasibility Percentages

Validator	Feasibility Percentages	Criteria
Mathematic Learning Media Expert	91 %	Very proper
Mathematic Learning Material Expert	92,8%	Very proper

Based on the table above, it can be seen that learning media developed has percentages > 60%, they are 91% and 92.8%. Where, based on the criteria which has been decided, so learning media developed is proper to be used.

Table 3. Practicality Questionnaire Average Score First Trial of Mathematic Learning Media

Aspect Observed	Practicality Score (%)	Practicality Criteria
Effective aspect	80,13	Practical
Interactive aspect	80,23	Practical
Interesting aspect	79,17	Practical
Efficient aspect	80,81	Practical
Creative aspect	78,79	Practical

Based on the learning media practicality criteria explained in chapter III before, so it can be concluded that mathematic learning media developed is practical.

3.3. Effectiveness Description of Mathematic Learning Media Based on Macromedia Flash Developed in First Trial

Table 4. Results Description of Students' Spatial Ability in First Trial

Explanation	Spatial Ability Test Score	Predicates
Highest score	83,33	B+
Lowest score	20,83	D-
Students' average score	67,93	

Students' average spatial ability on the test result is 67.93. If it is categorized based on students' mastery level, so the students' mastery level on spatial ability in the first trial can be seen in the table below:

Table 5. Classification of Students' Spatial Ability Mastery Test Results

No	Score Interval	Amount of students	Percentage	Category
1	$0 \leq NKS < 54$	6	18,18%	Very low
2	$54 \leq NKS < 65$	1	3,33%	Low
3	$65 \leq NKS < 79$	23	69,69%	Average
4	$79 \leq NKS < 89$	3	9,09%	High
5	$89 \leq NKS < 100$	0	0%	Very high

For more clear information, it can be seen in the diagram below:

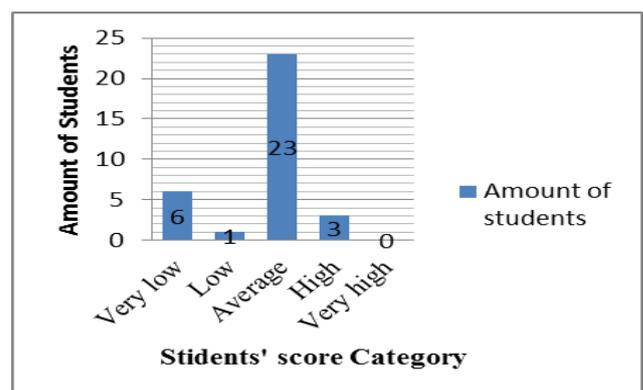


Figure 1. Students' Spatial Ability Level Test Results in First Trial

Based on the diagram above, it is reached that students' spatial level test results in first trial was dominated by average score category followed by very low category, then high category and high category. Then, students' spatial ability mastery result classically in first trial can be seen in the table below:

Table 6. Students' Spatial Ability Classical Mastery Level in First Trial

Category	Students' spatial ability	
	Amount of students	Percentage
Complete	26	78,78%
Not complete	7	21,21%
Amount	33	100%

Based on the table above, it can be seen that students' learning mastery classically from the students' spatial ability test is 26 students are completed from 33 students or it is only 78.78% students who got complete score classically. So, it can be concluded that in the first trial the using of Macromedia Flash developed has not been required to fulfill mastery criteria classically.

Data analysis results on students' response questionnaire to mathematic learning media based on Macromedia Flash developed can be seen that percentage results from all statements show positive answers that is 95.76%, while there is 4.24% students show negative answers.

3.4. Practicality Analysis on Mathematic Learning Media Based on Macromedia Flash Developed in the Second Trial

Table 7. Average Score of Practicality Mathematic Learning Media Questionnaire in Second Trial

Aspect Observed	Practicality Score (%)	Practicality Criteria
Effective aspect	82,58	Practical
Interactive Aspect	83,29	Practical
Interesting Aspect	80,15	Practical
Efficient Aspect	84,56	Practical
Creative aspect	77,94	Practical

Based on Learning media practicality criteria above, it can be concluded that mathematic learning media developed is practical.

3.5. Mathematic Learning Media Effectiveness Analysis Based on Macromedia Flash Developed in Second Trial

Table 8. Description of Students' Spatial Ability Results in Second Trial

Explanation	Students' Spatial Ability Test Score	Predicate
Highest Score	93,75	A-
Lowest Score	60,42	C+
Average	84,13	

If it is categorized based on the mastery level, the mastery level of students' spatial ability on the test results in second trial can be seen in the table below:

Table 9. Classification of Students' Spatial Ability Mastery Test Results

No	Score Interval	Amount of students	Percentage	Category
1	$0 \leq NKS < 54$	0	0%	Very low
2	$54 \leq NKS < 65$	3	8,82%	Low
3	$65 \leq NKS < 79$	0	0%	Average
4	$79 \leq NKS < 89$	21	61,76%	High
5	$89 \leq NKS < 100$	10	29,41%	Very High

For more clear information, it can be seen in the diagram below:

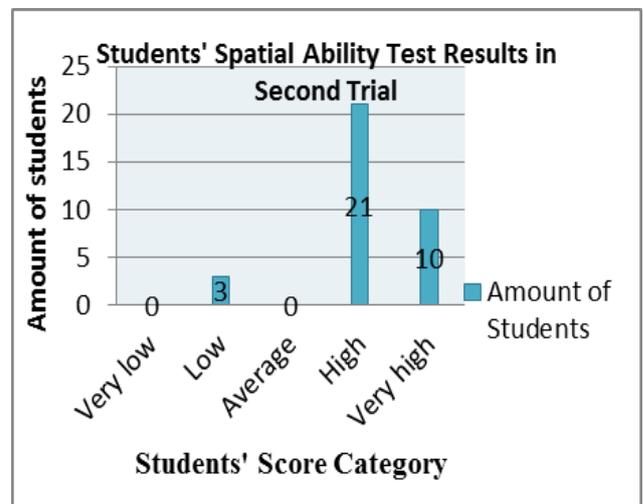


Figure 2. Students' Spatial Ability Level Test Results in Second Trial

Then, students' spatial ability mastery result classically in second trial can be seen in the table below:

Table 10. Students' Spatial Ability Classical Mastery Level in First Trial

Category	Students' Spatial Ability	
	Amount of Students	Percentage
Complete	31	91,18%
Not Complete	3	8,82%
Amount	34	100%

So, it can be concluded that in the second trial, implementing learning media based on Macromedia Flash developed has fulfilled the mastery classically criteria. Data analysis results of students' response questionnaire to mathematic learning media based on Macromedia Flash developed can be seen that percentage result from all statements show positive answers of 98.24%, while 1.76% students show negative answers. If this result is referred to the criteria decided in chapter III, it can be concluded that students' response to learning media is positive, because more than 80% students gave positive response to learning media based on Macromedia Flash developed.

3.6. Description of Students' Spatial Ability Improvement Using Mathematic Learning Media Based on Macromedia Flash Developed

Table 11. Description of Students' Spatial Ability Test Results

Explanation	Students' Spatial Ability Test Result in First Trial	Students' Spatial Ability Test Result in Second Trial
Highest Score	89,58	93,75
Lowest Score	20,83	60,42
Average	67,93	84,13

So, it shows that there is an improvement on average score in students' spatial ability as 16.2.

Then, the description of students' spatial ability improvement in first trial and second trial for each spatial ability indicator can be seen in the table below:

Table 12. Description of Students' Spatial Ability Test Result for Each Indicator

Students' spatial ability indicator	Average		
	First Trial	Second Trial	Improvement
Orientation	6,88	7,26	0,38
Mental Rotation	5,82	6,41	0,59
Visualization	5,52	7,50	1,98
Perception	4,30	5,94	1,64
Relation	5,33	6,06	0,73
Disembedding	5,99	7,21	1,22

For more clear information, it can be seen in the diagram below:

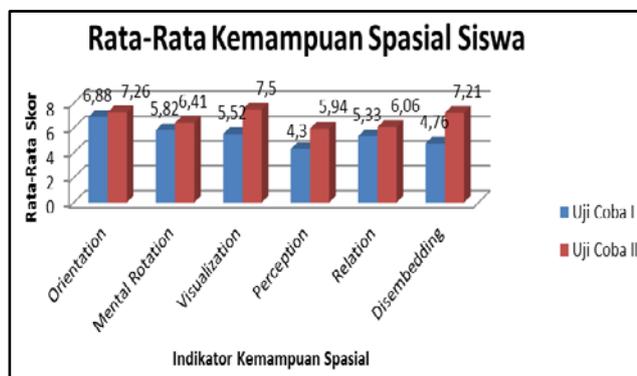


Figure 3. Students' Spatial Ability Average Score for Each Indicator

So, it can be concluded that the using of mathematic learning media based on Macromedia Flash developed have an impact on improving students' spatial ability.

4. Conclusion

Based on the analysis and discussion results in this research, it can be concluded that:

Mathematic learning media validation which was developed is valid if it is seen from learning media

validity score with media validity average score is 4.55 from media expert and 4.64 from learning material expert, then lesson plan validity total is 4.48; worksheet is 4.62; and spatial ability test and students' mathematic learning motivation is also valid. Mathematic learning media developed is effective, if it is seen from students' learning mastery classically has achieved 91.99% on second trial, then students' response is positive to learning media developed, and the using of learning time using learning media has been ideal. The improvement of students' spatial ability using learning media developed on solid geometry material (cube and cuboids), the average score is improving from 70.45 in the first trial became 84.99 in the second trial. Average score for each indicator of spatial ability is also improving from the first trial to second trial.

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