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The effectiveness of using animation media to improve mathematical logic intelligence

Latif Al Ahmasi[1], Siti Sarah[1]✉, Saudah[2], Muhammad Isa[2]

[1]Madrasah Ibtidaiyah Teacher Education, Universitas Islam Negeri Profesor Kiai Haji Saifuddin Zuhri Purwokerto
Jl. Ahmad Yani No. 40 A Purwokerto Utara, Banyumas, 53126, Indonesia
[2] Elementary teacher education, Universitas Serambi Mekah
Jl. Tgk. Imum Lueng Bata, Batoh, Lueng Bata, Kota Banda Aceh, 23245, Indonesia
✉sitisarah@uinsaizu.ac.id

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Abstract: Mathematics is the main subject. Mathematics solves many problems in many fields, namely biology, physics, chemistry, astronomy, calculus, statistics, computer programming, and others. However, many students often consider mathematics as a complex subject. One of the reasons is that students are not trained to include mathematics the problem-solving process. Mathematical, logical intelligence is the ability to solve aproblem by mathematics. Living in the 21st century demands the use of technology in almost all aspects of life. This study aims to determine the effectiveness of animation media in improving the mathematical logic intelligence of fifth-grade students at an elementary school with 37 students. The research method is a quasi-experiment with a control-group pretest-posttest design. Research instruments in the form of tests and documents. Data analysis techniques using t-test and N-Gain calculation. The results showed that using animation media to learn mathematics effectively improves mathematical logic intelligence. It is evidenced by the experimental class N-Gain score of 69% with a reasonably practical category, which is higher than the control class N-Gain score of 52% with a less effective category. The t-test results show a difference in mathematical logic intelligence between students who learn using animation media and those who do not, with a significance value smaller than 0.050, namely 0.036. This research will inform that mathematical logic intelligence can be carried out using animation media. The other researcher can continue the research by finding the mathematical logic intelligence indicator that contributed the most to mathematics learning activity.

Keywords: effectiveness, animation media, mathematics learning, mathematical logic intelligence.

A. Introduction

Mathematics is a science that studies abstract concepts and is related to many fields of life, such as science, technology, economics, and society. Mathematics is also a

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language and communication tool that helps humans understand and explain phenomena (Fahrurrozi & Hamdi, 2017). Mathematics education at the elementary school/madrasah Ibtidaiyah level aims to introduce the basic principles of mathematics, build logical, critical, and creative thinking skills in students, and support students in applying mathematical principles in daily activities (Wandini, 2019). The goal of the 2013 curriculum in learning is to improve math skills (Tresnaningsih, 2014). Meanwhile, the Merdeka curriculum aims to teach mathematics so students can think logically and apply mathematical logic intelligence in everyday life (Fitrianawati et al., 2022).

The ability to think logically is one of the essential objectives of learning mathematics, one of which is the ability of mathematical logic intelligence, which includes inductive and deductive reasoning, systematic calculations, and the ability to recognize abstract patterns and relationships (Taylor, 2004). These skills are essential in the modern era for daily life and careers that require systematic analysis of situations, evidence collection, hypothesis generation, and logical inference. It also helps to understand basic and applied concepts in natural sciences and mathematics (Devianti, 2013). In addition, this ability opens up opportunities for study, career, and innovation in fields such as physics, chemistry, biology, astronomy, calculus, statistics, computer programming, and others.

The quality of mathematics learning outcomes has yet to match the importance of mathematics in life. One of the challenges in teaching mathematics is getting students interested and motivated to learn. Math is often considered a difficult and tedious subject by many students. It can be caused by various factors, such as uninteresting teaching methods, students' lack of interest in mathematics, or students' misunderstanding of mathematical concepts. If these issues are not appropriately addressed, students will lose interest in learning mathematics, which can hurt their logical and critical thinking skills (Mukminah et al., 2021).

Low interest and motivation to learn math also occur in MI Ma'arif NU Kutawis students in Purbalingga, Central Java. The results of an interview with the fifth-grade teacher of MI Ma'arif NU Kutawis revealed that improving student learning achievement in mathematics learning is one of the school's main focuses. Evaluations that have been conducted show that the average score of students in mathematics is in the range of 80 to 84. However, this score has yet to be evenly distributed. There are still many students who need to reach the Minimum Graduation Criteria. Classroom

teachers also still need to start using learning media in learning activities. Even if you hear information from the teacher, the school provides adequate facilities and infrastructure, including a projector, to create effective learning. This information becomes the basis for determining steps to improve learning, significantly to help students who still need to reach the Minimum Graduation Criteria.

Based on the problems experienced by the fifth-grade teacher of MI Ma'arif NU Kutawis and several available facilities, the research will focus on using animation media in mathematics learning to increase mathematical, logical intelligence. Animation media is chosen because the evaluation situation on the class shows that the student never iesies using media, but the school has adequate facilities to support it. On the other side, the 21st century is the technological era. It means that so many tools use technology in any situation and anyone, including the student. Now, technology is not a special tool for students. They use it in every situation, including studying. Mathematical logic intelligence is chosen because it is a basic skill in mathematics achieving (Ndia et al., 2019; Rusmana & Wulandari, 2020). However, the results of observations of teachers at MI Ma'arif NU Kutawis students in Purbalingga have not implemented a learning process that leads to achieving mathematical logic intelligence, like logical thinking with the ability to organize ideas systematically, abstract thinking with the ability to understand complex mathematical concepts, and analytical thinking using the ability to describe and solve mathematical problems.

Animation media is one of the learning tools that keeps students from being bored and increases student interest (Tyas, 2016). This media displays colored images sequentially on a projector screen, making it look like a living picture. Animation media can help students understand complex math concepts and solve problems logically and analytically (Apriadi, 2021). Animation media is an audio-visual learning media that can teach mathematical logic intelligence and can be used to improve it (Hariati et al., 2020). The other research finds that using education game media increases mathematical logic intelligence (Puspaningrum et al., 2023).

There are so many variations of animation media like powerpoint, cards, animation media like video, powerpoint, Adobe Acrobat, and so on. This research chooses an animationvideo using Adobe Illustrator software to design two-dimensional vector graphics and Filmora software to edit and unify videos. These two software were selected because they are easy to use, have advanced features, and have

lightweight capacity. The selection of this type of animation media also considers the availability of projector media and other supporting tools at MI Ma'arif NU Kutawis.

Based on various theoretical studies and relevant research results, this study aims to determine the effectiveness of animation media in improving mathematical logical intelligence in learning mathematics at MI Ma'arif NU Kutawis V. There are five indicators of mathematical logic intelligence namely logical thinking with the ability to organize ideas systematically, abstract thinking with the ability to understand complex mathematical concepts, deductive thinking with the ability to conclude from given premises, inductive thinking with the ability to collect data, and analytical thinking using the ability to describe and solve mathematical problems. This research is essential to provide information about the importance of achieving mathematical logical intelligence in supporting the achievement of mathematics learning, as well as other sciences considering that mathematics is widely used as a tool for other fields. In addition, the results of this study can be the basis for mathematics teachers that the implementation of effective mathematics learning can be carried out even with limited school facilities and infrastructure.

B. Method

This study uses quantitative methods to test the causal relationship between the variables studied. The quantitative method is a research method that seeks to determine the extent to which the independent variable affects the dependent variable. This type of research is quasi-experimental, which resembles an experiment but does not have complete control over the variables that affect the results. This research onlyhas one goal, mainly how is the effect of animation media in learning to achieve mathematical, logical intelligence. This research 'don't want to know how the effect of animation media on the other aspects. This study used a control-group pretest-posttest design to measure the effect of the intervention (Sugiyono, 2017). This design involves two randomly selected groups. Table 1 shows the control-group pretest-posttest design.

Tabel 1. Control-group pretest-posttest design

Class	Pretest	Treatment	Posttest
Eksperiment	O1	X	O3
Control	O2	Y	O4

Description :

X : Learning using animation media

Y : Learning without using animation media
O1 and O2: Pretest
O3 and O4: Posttest

The subject's research was students on fourth-grade MI Ma'arif NU Kutawis students learning math material on fractional numbers, with as many as 37 people. All students were divided into two groups. The first group carried out math learning using animatio media with 19 students. It is called the experimental class. The other group of 18 students carried out math learning without using animation media. It is called the control class. The learning method in the control class used a direct instruction strategy. Learning in the experimental class was equipped with a projector. However, in its implementation, the math learning in the experimental class was only fully attended by 14 students. The same thing also happened in the control class, where the learning was only fully attended by 14 students. Students who did not participate in learning because some participated in competitions, while others were sick. Considering that the research results will not capture the data as a whole, data analysis will only be carried out on students who fully participate in learning from beginning to end.

The data collection method is a written test comprising ten questions about fractional number material. The test is used because of the domain knowledge of the research, namely cognitive. There is only one research variable, namely mathematical logic intelligence. Mathematical logic intelligence is the ability to think inductively and deductively, think logically, analyze patterns of numbers, and solve problems by using abstract and analytical thinking skills. Indicators of mathematical logic intelligence include five things, namely logical thinking with the ability to organize ideas systematically, abstract thinking with the ability to understand complex mathematical concepts, deductive thinking with the ability to conclude from given premises, inductive thinking with the ability to collect data, and analytical thinking using the ability to describe and solve mathematical problems. Each indicator of mathematical logic ability is broken down into two indicators of questions so that the total test items are 10.

The test instrument has been declared to meet content validation by three expert lecturers in mathematics learning with very high criteria. The test trial will be done by 37 fifth-grade students in MI NU Kutawis. The trial results showed that there were only nine questions out of 10 questions that met the empirical validity and reliability tests.

Therefore, this study only took data using nine valid and reliable items. The test is done by all of the fifth-grade students of MI Ma'arif NU Kutawis.

The students were divided into two groups randomly. One group is the experiment class. The other is the control class. The experiment class studied using animation media, but the control class did not study using it.

Data analysis used the calculation of N-Gain scores to determine the effectiveness of animation media on the mathematical logic intelligence of fifth-grade students of MI Ma'arif NU Kutawis. N-Gain scores were interpreted using Table 2 (Hake & Reece, 1999).

Tabel 2. Interpreting the N-Gain score

Presentase (%)	Kategori
<40	Less effective
50-55	Not effective
56-75	Moderately effective
>76	Effektive

Besides the N-gain score, data was analyzed by independent sample t-test. It determines the difference in mathematical logic intelligence between the control and experiment classes (Sugiyono, 2017).

C. Result and Discussion

This study aims to determine the effect of two-dimensional media on improving mathematical logic intelligence in learning mathematics material on fractional numbers in class V MI Ma'arif NU Kutawis with as many as 38 students. The study used two groups: the control group and the experimental group. The control group learned with the lecture method without animation media, while the experimental group received learning with two-dimensional animation media projected using a projector.

All fifth-grade students of MI Ma'arif NU Kutawis totaled 37 students, divided into 19 students in the experimental class and 18 in the control class. However, the total number of students included in the study was only 28, divided evenly into the control and experimental classes of 14 students each. A total of 19 students were not involved because they needed to follow the learning thoroughly, which would make the research data biased if included.

Table 3 shows the pretest and posttest data of MI Ma'arif NU Kutawis's fifth-grade students in the control and experimental classes. To facilitate analysis, the data in Table 3 are summarized as shown in Table 4.

Table 3. Data on mathematical logic intelligence of control and experimental classes

Respondent	Control Class		Respondent	Experiment Class	
	Pretest	Posttest		Pretest	Posttest
1	3	20	1	2	39
2	16	30	2	13	38
3	11	27	3	7	38
4	8	31	4	19	26
5	19	35	5	9	25
6	16	36	6	12	26
7	6	25	7	19	26
8	16	28	8	8	30
9	16	26	9	11	27
10	17	38	10	15	30
11	13	26	11	2	25
12	13	30	12	17	39
13	13	25	13	4	33
14	5	28	14	9	28

Table 4. The summary of data description of students' mathematical logic intelligence in control and experimental classes

Data	Minimum Score	Maximum Score	Average	Median	Mode	Std. Deviasi
Pretest on Control Glass	3	18	11,43	13	16	4,50
Pretes eksperimen	2	17	9,50	10	2	5,03
Posttes kontrol	17	31	24,29	28	25	3,60
Posttes eksperimen	22	35	28,14	29	26	5,43

Table 4 shows that the lowest pretest score in the control class is higher than the experimental class. It also happened to the highest score. However, the opposite happened to the lowest post-test score; the score in the experimental class was higher than that of the control class. It also occurred in the highest value score. Other information that can be analyzed from Table 4 is the average score. The average pretest score of students in the experimental class is lower than the control class. However, on the contrary, the average post-test score of the experimental class is higher than that of the control class. From observing the median data, it can be analyzed that the pretest and post-test data in the control class shows that many students' scores above the average are far more than those below the average. The opposite occurred in the median data for both the pretest and post-test in the experimental class, which showed that the acquisition of data above and below the average was more balanced. The

standard deviation data shows that the experimental class pretest scores are much more varied than the control class. The same thing also happened to the post-test data.

The data in Table 4 determine the N-gain calculation to measure which class improves more. N-Gain is done by comparing the average score of posttests and pretests with the ideal maximum score that students can achieve if they answer all questions correctly. For information, the ideal maximum score is 9 question items, with each question item's maximum score being 10.

The score indicates that learning mathematics without animation media is less effective in improving students' mathematical logic intelligence. The results of the N-gain calculation in the experimental class, namely the class that used animated media in learning mathematics on fractional number material, resulted in 69%. The score shows that the animation media is compelling enough to improve students' mathematical logic intelligence in fractional numbers. Figure 1 shows the results of the N-Gain score between the control and experimental classes and more clearly shows the differences.

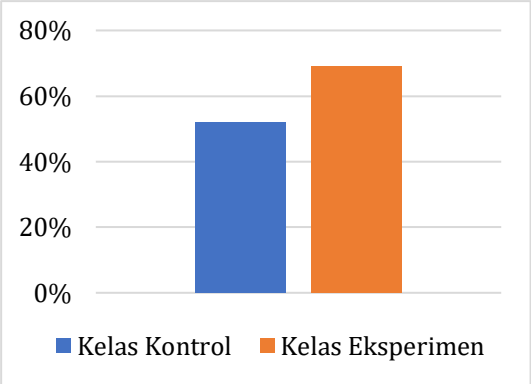

Figure 1. N-Gain score results between the control class and experimental class

The N-gain calculation will be more convincing if it is continued with a statistical test, namely the independent sample t-test, used to determine whether the difference in effectiveness between the control and effective classes is significant. For that, a prerequisite test will be carried out first. The test includes a normality test and a homogeneity test. Table 5 shows the results of the normality test using the Kolmogorov-Smirnova formula.

Table 5. The result of normality test

Class	Kolmogorov-Smirnova		
	Statistic	Df	Sig.
Pretest in Control Class	0,176	14	0,200
Posttest in Control Class	0,174	14	0,200
Pretest in Experiment Class	0,117	14	0,200
Posttest in experiment Class	0,217	14	0,074

The Kolmogorov-Smirnov normality test results show that the significance of the control class pretest and posttest is more significant than 0.05, namely 0.200. The same thing is also found in the experimental class pretest and posttest data, which are also greater than 0.05, namely 0.200 and 0.074, respectively. This shows that the data comes from a normally distributed population. Thus, the analysis continued by conducting a homogeneity test. The results of the homogeneity test using the Levene test are in Table 6.

Tabel 6. The result of homogeneity test

Class	Df2	Sig.
Based on mean kontrol	26	0,392
Based on mean eksperimen	26	0,495

Table 6 shows that the results of the data homogeneity test in the control class and experimental class all show significance greater than 0.05, namely 0.392 for the control class and 0.495 for the practical class. Because the significance value for data in both classes is more significant than 0.05, it is concluded that the data comes from a homogeneous population.

The fulfillment of the two prerequisite tests, namely the normality test and the homogeneity test, shows that the data meets the criteria to be tested using the parametric statistical test format with the research objectives and research design as a reference. The research objective is to determine whether a statistically significant difference in mathematical logic intelligence exists between the control and experimental classes. The research design was a control-group pretest-posttest design. Therefore, the suitable statistical test used is the independent sample t-test.

Table 7 shows the results of the independent sample t-test using the spss application.

Table 7. The results of the independent sample t-test

	T	df	Sig. (2-tailed)
Equal variances assumed	-2.214	26	0,036
Equal variances not assumed	-2.214	22.585	0,037

Table 7 shows that 28 data from 2 classes with a degree of freedom (df) 26 show a significance value of 0.036. The values are lower than 0.05. There is a significant difference in mathematical logic intelligence between the control class and the experimental class. Looking back at the data in Table 4 and Figure 1 shows that the difference in posttest and pretest scores in the experimental class is higher than in the control class. This result confirms a significant difference in mathematical logic intelligence between students who learn math using animation media and those who

do not. Furthermore, the increase in mathematical logic of students who know how to use animation media is higher than that of those who do not use animation media.

A deeper discussion of the research results is carried out by linking them with other people's relevant research to determine the position, difference, and novelty of this research. The background of this research is the demands of the times, namely the 21st century with the Industrial Revolution 4.0 and Era Society 5.0, where technology is one thing that cannot be separated, including education (Maritsa et al., 2021). This means integrating technology use into the learning process is a must. The various conveniences of technology need to be balanced with the ability to survive in life. One of the indispensable competencies is mathematical logic intelligence, which is intelligence that leads to students' ability to think critically and creatively and problem-solving skills. Taylor (2004) states that mathematical logic intelligence includes inductive and deductive reasoning, systematic calculation, and the ability to recognize abstract patterns and relationships.

1. In-depth analysis of increasing mathematical logic intelligence through learning mathematics using animation media

This study aims to determine the efficiency of using animation media in mathematics learning to improve mathematical logic intelligence. The research finds that learning mathematics using animation media significantly improves mathematical logic intelligence with N-gain score 0,495 which higher than learning mathematics without using it. The independent sample t-test also states the same thing with a significance of less than 0.05.

There are researchers Haris et al. (2023), Puspaningrum et al. (2023), Sari et al. (2023), Saripudin et al. (2023), and Ulliyah et al. (2023) whose doing research in mathematical logic intelligence and found the same result. It means that mathematical logic intelligence can increase by media. But they use different media. The research by Puspaningrum et al., (2023) and Sari et al. (2023) reached mathematical logic intelligence from game for child in 5 to 6 years. The other research reached it from fun book media in 5 to 6 years children (Haris et al., 2023) and interactive e-module in elementary school students (Ulliyah et al., 2023). All the researchers find that mathematical logic intelligence can reach with fun media. The animation media which uses in this research also includes the fan media. It is because there are many games in it, so many students enjoy playing it. If observed further it can be understood that the use of games (Puspaningrum et al., 2023; Sari et al., 2023) and interactive e-module

(Ulliyah et al., 2023) are media that use information technology in their use. It is also in line with the nature of the animated media used in this study, namely that the media gives a positive influence in activating mathematical learning (Ayuningdyah & Khotimah, 2018). Thus, the association of the results of the research with previous research has been known. Besides that, research by Haris et al. (2023), Sari et al. (2023), and Ulliyah et al., (2023), the results of this research show that mathematical logic intelligence can be achieved at various levels of education, namely early childhood education and basic education. This becomes material for future research, can mathematical logic intelligence be achieved at the next level of education, namely secondary and tertiary education? This requires an answer through further research.

Besides that, research by Harris et al. (2023), Sari et al. (2023), Ulliyah et al., (2023) and the results of this research show that mathematical logic intelligence can be achieved at various levels of education, namely early childhood education and basic education. This becomes material for future research, can mathematical logic intelligence be achieved at the next level of education, namely secondary and tertiary education? This requires an answer through further research.

In addition, animation can also help students learn mathematics, fundamental mathematical concepts that are often difficult to understand verbally or with static images. With animation, students can see the processes and relationships between mathematical concepts dynamically and interactively (Adi et al., 2019). Thus, animation is a valuable learning tool in stimulating students' ability and activeness in learning, as well as fun for students.

2. The learning techniques to achieve mathematical logical intelligence

Besides using interactive animation media, logical intelligence can be achieved through learning techniques that activate learning activities. This has been proven by Suningsih (2016) who used the Think Talk Write strategy to increase mathematical logic intelligence. Another research conducted by Mufarizuddin (2017) succeeded in proving that the technique of playing cards can increase mathematical logic intelligence. The research by Sari et al. (2023) also carried out the same thing regarding playing activities in learning and being able to improve mathematical logic intelligence. The use of the Problem-Based Learning method has been proven to be able to increase mathematical logic intelligence variables (Hayati et al., 2023). Research by Azinar et al. (2020) shows that improving logical-mathematical intelligence in the indicators of numeracy and problem-solving is not easy. It needs more effort to get it.

Based on several results of this research, it can be concluded that increasing mathematical logic intelligence can not only be achieved through learning media but also using learning techniques that refer to challenging and fun learning activities. This is also a breakthrough for other researchers who will carry out research to combine the use of media and learning techniques with the hope that the percentage of success in increasing mathematical logic intelligence will be better if compared to just doing one treatment, namely media alone or technique alone. This has been proven by (Sari et al., 2023) who used number dice and games in learning.

3. The other effect of learning using animation media

The use of animation media in learning affects mathematical logic intelligence and other variables, such as improving students' thinking skills (Permana et al., 2020). The results of the research by Maritsa et al. (2021) state that animation media is one of the learning strategies that can increase the teaching and learning process. Using animated media also effectively attracts students' attention, facilitates material delivery, and enriches the learning experience (Mohama et al., 2023). Research conducted by Anggraini (2021) also states that animation media can positively influence students' interest in learning and help them understand the material more easily. Animation can stimulate students' brains to think creatively, logically, and critically to increase their intelligence (Khumaeroh, 2022). Actually, student thinking skills, learning process, students' attention, the learning experience, and understand the material are a part of mathematics logic intelligence indicator includes inductive and deductive reasoning, systematic calculations, and the ability to recognize abstract patterns and relationships (Taylor, 2004).

This study's increase in mathematical logic intelligence is sufficient. It is due to the implementation of the research in five weeks only. It is related to the limited permission given by the school. Nevertheless, looking at the results of the study, which showed an upward trend, and the results of other people's relevant research raises an optimistic attitude that the longer the learning is carried out using animated media, the higher the increase in mathematical logic intelligence will be.

D. Conclusion

This study concluded that animation media effectively improves the mathematical logic intelligence of fifth-grade students at MI Ma'arif NU Kutawis. It is

evident from the N-Gain score of the experimental class, which reached 69% (moderately effective), and the control class, which was 52% (less effective). In addition, the independent sample t-tests showed a significance value of 0.03. It is smaller than 0.05. It indicates a significant difference in mathematical logic intelligence between the experimental and control classes. Thus, the use of animated media in learning mathematics is more effective than without using animated media in improving the mathematical logic intelligence of fifth-grade students of MI Ma'arif NU Kutawis.

The results of this study only apply to the mathematical learning of fractional number matter in fifth-grade students of MI Ma'arif NU Kutawis. The abundance of mathematical material makes it possible to produce varied research results. The possibility also will happen to others student. The rapidly growing animation media in the age of technology is another consideration in the quest for achieving mathematical logic intelligence. In addition, mathematical logic intelligence as a variable that supports student access to mathematics learning has an important position to be examined in greater depth. Besides, considering mathematics as a science that is used in many fields. The abundance of mathematical logic intelligence indicators needs to be followed more deeply. It aims to find indicators that play the most role in determining mathematical logic intelligence in order to ensure the most effective treatment for better access to mathematics learning. Therefore, other research related to mathematical logic intelligence is very open to development.

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