Investigating the effectiveness of using various

by Nanang Supriadi

Submission date: 11-Jan-2023 03:11PM (UTC+0700)
Submission ID: 1991141921
File name: 12485-41595-6-PB.pdf (437.59K)
Word count: 4306
Character count: 24745

Al-Jabar: Jurnal Pendidikan Matematika
Volume 13, Number 1, 2022, Pages 189 – 198
http://ejournal.radenintan.ac.id/index.php/al-jabar/index

Investigating the effectiveness of using various mathematics learning media among students with various learning styles

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Artikel Information
Submitted Jan 21, 2022
Revised May 28, 2022
Accepted June 01, 2022

Keywords
Effectiveness;
Learning style;
Mathematics learning media.

Abstract
Appropriate mathematics learning media is one factor determining the success of learning mathematics. Teachers can use various types of media to help students learn mathematics. However, teachers must consider the learning media's suitability with students' characteristics. This study aims to 1) reveal the most effective learning media for visual, auditory, and kinesthetic learning styles; 2) determine the interaction between learning media and learning styles on students' mathematics achievement. Therefore, this study used a 3 × 3 factorial design. The sample in this study was 29 eighth-grade students in junior high school. Researchers used questionnaires and mathematics achievement tests to collect research data to be analyzed quantitatively. The results show that interactive applications are the most effective learning media for students with different learning styles. Besides, there is a significant interaction effect between learning media and learning styles on students' mathematics achievement.

INTRODUCTION

Students need sources and learning media that can make them easier to understand concepts (Rachmawati et al., 2020; Syandri, 2015). Fascinating learning media will attract more interest, attention, and understanding to the information presented (Taufik et al., 2022). But in reality, learning media is still not used optimally. The presentation of theoretical and conceptual lecture material in mathematics subjects will not be effective without using the correct learning materials and media. Meanwhile, the benefits of learning media are to clarify the presentation of learning content while attracting students' attention and improving learning motivation to impact the students' learning outcomes (Setiawan & Soeharto, 2020).

Learning media is also helpful for equalizing students' perceptions and strengthening the material to be delivered by the teacher (Djatmiko et al., 2021). The teacher conveys and accepts the message to stimulate the student's thinking, emotions, attention, or willingness to strengthen the learning process (Dewi et al., 2022). So, mathematics learning media are all things that can channel messages and stimulate students' minds in the process of learning mathematics (Saputra et al., 2021). Furthermore, teachers can design the appearance and features of teaching media as attractive as possible to increase students' motivation and learning engagement (Maryam & Sampoerno, 2021). Therefore, the development of the mathematics learning media by utilizing the existing technological developments is needed (Fazira & Qohar, 2021).

How to cite Laswadi, L., Supriadi. N., Khaidir, C., & Anggoro, B. S. (2022). Investigating the effectiveness of using various mathematics learning media among students with various learning styles. *Al-Jabar: Pendidikan Matematika*, *13*(1), 189-198.
E-ISSN 2540-7562
Published by Mathematics Education Department, UIN Raden Intan Lampung

Empirical research shows that mathematics learning media increases achievement, conceptual understanding, and procedural fluency (Laswadi et al., 2016). Furthermore, Septian & Monariska (2021) found that the result of using math software was better in improving students' mathematical understanding ability than improvement through ordinary learning. In addition, the research conducted by Farida (2015), found that learning media can be used to improve students' reasoning and communication skills and improve the learning outcomes of learners. Therefore, learning media is essential in influencing one's abilities (Maskur et al., 2020). Lastly, using learning media can reduce students' anxiety levels (Maharani et al., 2018).

There are many types of learning media, such as pictures, transparencies, slides, audio and video recording, multimedia, and certain types of hardware or software media (Kounlaxay et al., 2021). Recently, many media types have been available for learning mathematics. However, a teacher must ensure that the media is based on student characteristics. Salomon's concept of AIME explains that certain media are more efficacious for children than others (Neuman, 2009). In line with this concept, Widodo & Wahyudin, (2018) found that each learning media has uniqueness. Therefore, choosing media for learning requires attention and knowledge.

Himayaturohmah, (2019) states that learning media plays a crucial role in the success of a learning process. He explained that the ability of teachers to understand learning media will have implications for the quality of learning in the classroom. To understand the media well, a teacher must recognize the types of media to determine the media that students need for their learning. Recognizing the type of media helps the teacher to be able to give it to students. Media is divided into two major groups: traditional media and cutting-edge technology media. Traditional learning media consist of print media, visual media, audiovisual media, real media, game media, and computer-based media. Meanwhile, the latest technological media consists of telecommunication-based and microprocessor-based learning media (Ariyanto et al., 2018).

In addition to choosing suitable learning media, student learning style factors also determine learning outcomes (Nurwidayanti & Mukminan, 2018). Learning styles, on the other hand, represent an important issue in learning in the twenty-first century, with students expected to participate actively in developing self-understanding and their environment engagement (El-Sabagh, 2021). Learning styles were used to identify students' characteristics to create homogenous and heterogeneous groups (Orsini et al., 2022). The presence of various learning styles is related to students' different abilities and individual preferences to learn (Baherimoghadam et al., 2021).

Three learning styles are classified based on linguists' teaching namely 'visual,' 'auditory,' and 'kinesthetic' (Aronet et al., 2022). Vision plays an essential role in learning for students with visual learning styles. They think using pictures in their brains and learn faster using visual displays, such as diagrams, picture textbooks, and videos. Different from students with visual learning styles, students with auditory learning styles depend on the success of their learning through hearing. They can digest the meaning conveyed through the tone of voice, pitch (high and low), speed of speech, and other auditory things. The final learning style is kinesthetic. Students with this learning style learn through moving, touching, and doing. They don't like to sit still for hours because activities and exploration are more fun. This research involves the latest technological media, namely PowerPoint slides, instructional videos, and interactive applications.

The results of empirical research reveal that to optimize mathematics learning achievement, teachers must create learning that accommodates students' different learning styles (Bosman & Schulze, 2018). Next, research from Jehadus et al., (2019) describes a significant relationship between learning styles and students' mathematics learning achievement. Lastly, Kenny's analysis explains that students with visual and auditory learning styles will have better learning achievements compared to kinesthetic learning styles in learning and understanding the material (Widyawati, 2016). From previous studies, no research discusses the interaction of learning media on students' mathematics achievement regarding learning styles.

Based on the phenomena and symptoms of the problems above, the use of learning media and learning styles significantly influences student achievement in Mathematics. So this study aims to 1) reveal the most effective learning media for visual, auditory, and kinesthetic students; and 2) determine the interaction between learning media and learning styles on students' mathematics achievement.

METHODS

This study uses quantitative methods. The design used is an experiment with a 3 x 3 factorial design with a pretest and a posttest. A factorial design can show how one variable moderate another. The population of this research is all junior high school students, while the sample of this study was 29 eighth-grade students in the first semester. The process of determining the sample using simple random sampling. In this study, students' learning styles moderate the use of learning media. Therefore, the moderator variable in this study is student learning style.

Table 1. 3 × 3 Factorial Design

		Mathematics Learning Media (A)		
		PowerPoint Slides (1)	**Instructional Videos (2)**	**Interactive Applications (3)**
Learning Styles (B)	**Visual (1)**	A_1,B_1	A_2,B_1	A_3,B_1
	Auditory (2)	A_1,B_2	A_2,B_2	A_3,B_2
	Kinesthetic (3)	A_1,B_3	A_2,B_3	A_3,B_3

Table 1 shows nine groups of students involved in this study. The row shows the learning style, while the column shows the media used in each group's learning. The results of identifying the learning styles of each research subject determine the group's composition. Next, identify the learning styles of each subject using a questionnaire.

Table 2. The Results of the Identification of the Study Subject's Learning Style

No	Learning Styles	Students
1	Visual	6
2	Auditory	13
3	Kinesthetic	10

Table 2 shows the results of identifying learning styles for 29 students. These results will be divided into three classes using different learning media. The first class used PowerPoint slides. There are two students with visual learning styles, four auditory students, and four kinesthetic students. The second class used instructional videos. There are two visual students, four auditory students, and three kinesthetic students. The third class used an interactive application containing two visual students, five auditory students, and three kinesthetic students.

Before taking part in the lesson, all students took the pretest, followed by nine study sessions. The pretest was held on August 12, 2020. After the pretest, learning was carried out in two sessions a week. The first session was held on August 14, 2020, and the last session was held on September 18, 2020. After the ninth session, all students took the posttest. The posttest was held on September 23, 2020. Researchers used N-gain to observe the increase in student achievement before and after being given treatment. Furthermore, the value of n-gain is interpreted using the criteria of low, medium, and high.

Table 3. N-Gain Value Criteria

Interval (g)	Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

Hypothesis testing to test whether there is a significant difference between the variables of Learning Media and Learning Style on Learning Achievement using two-way Analysis of Variance (Two Way Anova).

RESULTS AND DISCUSSION

After getting pretest and posttest data, N-gain was calculated. The N-gain data is explained based on learning style variables, learning media variables, and a combination of two variables.

Table 4. Description of Students' Mathematics Achievements

	N	Min	Max	$\bar{X}$	SD	Variance
Pretest	29	3	19	8.86	4.30	18.48
Postest	29	42	79	61.21	12.19	148.67
N-gain	29	0.36	0.78	0.55	0.12	0.02

From table 4, it is found that there is no significant difference between students in the pretest results. We can see this from the small standard deviation values. The rating scale used in the pretest and posttest is 0 - 90. The low average of the pretest results indicates that, at first, students have not mastered the learning material. In contrast to the pretest, there was a big difference in the students' posttest results. A relatively large standard deviation value indicates an enormous difference. This significant variation is caused by students studying different groups with different treatments. The average value of the posttest results is also much greater than the average of the pretest results. This average value confirms that students have mastered the learning material. In addition, the average N-Gain value is 0.55. This value indicates that the increase in students' mathematical achievement is in the medium category. Based on the value of the standard deviation, it can be concluded that there is a significant difference in the increase in students' mathematical achievement. The reason is the same: students study in different groups with different treatments.

Table 5. Description of the Improvement in Students' Mathematics Achievement Based on Learning Styles

	N	Min	Max	$\bar{X}$	SD	Variance
Visual	6	0.57	0.77	0.67	0.09	0.01
Auditory	13	0.46	0.77	0.59	0.11	0.01
Kinesthetic	10	0.36	0.78	0.49	0.15	0.02

Based on table 5, the maximum value of increasing mathematics learning achievement from the three learning styles. It is known that students from the kinesthetic learning style make the highest progress in learning achievement. In addition, the maximum achievement of the three groups has reached the high criteria. Furthermore, based on the average scores of the three groups of students, students with visual learning styles were more successful in improving mathematics learning achievement. However, the average value of the increase in students' mathematics learning achievement from the three learning styles was $0{,}3 \leq g \leq 0{,}7$. Thus, the increase in student achievement in mathematics from the three groups reached the medium criteria. The standard deviation value of the group of students with visual learning styles is the smallest of the three groups, so it can be concluded that students with visual learning styles are more successful in improving mathematics learning achievement by the group.

Table 6. Description of the Improvement in Students' Mathematics Achievement Based on Learning Media

	N	Min	Max	$\bar{X}$	SD	Variance
Powerpoint Slides	10	0.39	0.77	0.50	0.12	0.01
Instructional Video	9	0.36	0.77	0.57	0.15	0.24
Interactive Application	10	0.51	0.78	0.65	0.11	0.01

Based on the maximum scores in Table 6, it was found that students from each group had achieved the criteria for high achievement improvement with a score > 0.7. Furthermore, students from the study group using interactive applications got the highest score. Therefore, learning with interactive applications resulted in the most significant improvement in students' mathematics learning achievement. In the Average value column, it was found that learning with interactive applications improved students' mathematics learning achievement more successfully. However, the three values show an average of $0{,}3 \leq g \leq 0{,}7$. Thus, the increase in student achievement in mathematics from the three groups reached the medium criteria.

Table 7. Description of the Improvement in Students' Mathematics Achievement Based on Learning Styles and Learning Media

		Mathematics Learning Media (A)		
		PowerPoint Slides (1)	**Instructional Videos (2)**	**Interactive Applications (3)**
Learning Styles (B)	**Visual (1)**	0.59	0.63	0.67
	Auditory (2)	0.49	0.55	0.62
	Kinesthetic (3)	0.41	0.39	0.68

Based on table 7, students with visual learning styles who learn with interactive applications get the highest average increase in mathematics achievement from the other two groups with the same learning style. Similar to students with visual learning styles, students with auditory and kinesthetic learning styles are more successful when using interactive applications. Table 7 also informs that the group with the highest achievement is the group with kinesthetic learning styles with interactive applications from nine groups.

Furthermore, inferential analysis was conducted to examine whether there was a significant difference in the improvement of mathematics achievement. There are three hypotheses to be tested, namely:

First hypothesis

H_0: there is no significant difference in students' mathematics achievement based on learning media

H_1: there is a significant difference in students' mathematics achievement based on learning media

Second Hypothesis

H_0: there is no significant difference in students' mathematics achievement based on learning styles

H_1: there is a significant difference in students' mathematics achievement based on learning styles

Third Hypothesis

H_0: there is no significant interaction between learning media and learning styles on students' mathematics achievement

H_1: there is a significant interaction between learning media and learning styles on students' mathematics achievement

Decision-making is based on the results of the analysis. If the probability value is less than 0.05 ($p<0.05$), then H_0 is rejected, and H_1 is accepted. The results of the two-way ANOVA are summarized in the following table.

Table 8. Two-way ANOVA Summary

Source	Sum of Squares	df	Mean Square	F	Sig.
Learning Media	.075	2	.038	4.349	.027
Learning Style	.114	2	.057	6.574	.006
Learning Media * Learning Style	.123	4	.031	3.540	.024
Error	.173	20	.009		
Total	10.015	29			
Corrected Total	.527	28			

Based on table 8, the significance value of the Learning Media variable is less than 0.05, so we reject H_0. Thus, we can say that there is a significant difference in students' mathematics achievement based on the learning media. Likewise, for the learning style variable, the significance value obtained was less than 0.05, so we reject H_0. Thus, we can conclude that there are significant differences in students' mathematics achievement based on learning styles. And lastly, the significance value for the interaction test between learning media and learning styles is less than 0.05, so we reject H_0. It can be said that there is a significant interaction effect between learning media and learning styles on students' mathematics achievement.

Differences in mathematics learning achievement also occur in students based on differences in learning media. This is confirmed by the results of the first hypothesis and is in line with previous research, which shows how instructional media have improved mathematics teaching outcomes (Farida, 2015; Laswadi et al., 2016; Muhammad, 2015). This finding also supports the opinion that as a teacher, you must be able to determine the right media and, simultaneously, reach all students (Mustaqim & Kurniawan, 2017). In addition, the results of the descriptive analysis show that students who learn with Interactive Applications get the highest achievement from the three media. Interactive applications involve many senses in the learning process. Thus, these findings follow the theory that the more senses involved in the

learning process, the easier it is for students to process and receive learning messages (Sofia, 2012).

The results of the second hypothesis confirm the findings of Bire et al. (2014) and Rambe & Yarni, (2019), which revealed that learning styles contributed significantly to learning outcomes and visual learning styles contributed the most compared to the other two learning styles. The results of the third hypothesis show an interaction between learning media and learning styles on students' mathematics achievement, empirically proving that each particular media has certain advantages in its ability to achieve learning objectives. (Abidin, 2016) This finding also supports the results of previous research, which shows that each learning media has unique characteristics and advantages (Widodo & Wahyudin, 2018). These findings show how important learning styles are in designing learning and selecting instructional media.

The calculation results show that the three learning styles interact well with interactive application media. These findings indicate that the interactive application caters to the needs of students with various learning styles. As recommended in previous studies (Bosman & Schulze, 2018), teachers must design learning that accommodates different student learning styles, so it can be suggested to use interactive applications as learning media that meet the needs of students with different learning styles. Many types of learning media are available today, causing this study to only examine the use of several media. Therefore, the researcher suggests that further researchers can study how other media interact with students' learning styles and additional aspects.

CONCLUSIONS

The analysis leads to the following conclusions: there is a significant interaction effect between learning media and learning styles on students' mathematics achievement; and interactive applications are the most effective learning media for students with different learning styles. Students with certain learning styles need to get an appropriate learning experience. However, this certainly makes it difficult for teachers who teach a group of students with various learning styles. Interactive applications are media that can engage multiple senses and engage students with various learning styles. Many types of learning media are available today. This study only examines several media. As a result, the researcher suggests that future researchers investigate how other media interact with students' learning styles and other factors.

AUTHOR CONTRIBUTIONS STATEMENT

L was a researcher who plays a role in preparing ideas, choosing research topics, compiling learning tools, determining research locations, processing research data, and compiling articles. Meanwhile, NS, CK and BSA wrote and analyzed the articles.

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