SigmaMu 3(2) (2025)

Journal of Mathematics, Statictics and Data Science

https://journals.balaipublikasi.id

The effectiveness of using tpack-integrated learning media on the learning outcomes of exponentiation among eighth-grade students

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Received : 16-04-2025
Accepted : 16-04-2025
Published : 26-06-2025

DOI: 10.56566/sigmamu.v3i2.347

Abstract: The background of this study is the low student learning outcomes, the ineffective learning process, and the lack of teacher interaction. This research aims to examine the effectiveness of using TPACK-integrated learning media on the learning outcomes of exponent numbers among eighth-grade students at SMP Negeri 1 Kediri. The research approach used is quantitative, with a research design of Pretest-Posttest Only Control Group Design. The population in this study includes all eighth-grade students at SMPN 1 Kediri, and the sampling technique used is purposive sampling. The selected sample consists of class VIIIC as the control group and class VIIIE as the experimental group. The research instruments include test questions, observations, and student response questionnaires. The data analysis techniques used in this study are descriptive and inferential statistical analysis. The learning media used include instructional videos, Liveworksheets-based LKPD, and Kahoot. The results of the study indicate that the use of TPACK-integrated learning media is effective in improving the learning outcomes of exponent numbers among eighth-grade students at SMP Negeri 1 Kediri in the 2024/2025 academic year. This effectiveness is demonstrated by: (1) An increase in the average learning outcomes of the experimental class by 0.7342, which falls into the high category. (2) A significant difference in the average mathematics learning outcomes between the control and experimental classes, as indicated by the independent sample t-test, where t_calculated > t_table (6.104 > 2.005).

Keyword: *Learning Media; TPACK; Exponentiation Learning Outcomes*

Introduction

Mathematics is a crucial discipline in the development of science and technology, as it encompasses fundamental principles that serve as the foundation for various aspects of life. This aligns with the statement made by Erayani et al. (2022), which emphasizes that mathematics plays a significant role as a tool for developing thinking patterns, both in everyday life and in the advancement of science and technology. Mathematics is one of the fields of knowledge that enables humans to think logically, rationally, and confidently, in addition to serving as a tool for solving

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real-world problems that can be simplified into mathematical models (Baidowi et al., 2019). Recognizing the vital role of mathematics, the success of mathematics education needs to be given proper attention.

Success in learning mathematics can be seen from the learning outcomes achieved by students. Learning outcomes represent the achievements obtained through conscious efforts made by students to bring about change, including in the aspects of knowledge, skills, and attitudes (Ananda & Hayati, 2020). Mathematics learning outcomes reflect the level of success students have in understanding the material taught, which is usually assessed using a numerical or letter grading system. This aligns with the statement made by Panie et al. (2023) that success in the mathematics learning process is determined by learning outcomes.

Mathematics learning outcomes play an important role in the learning process, as they can assess the development of students' cognitive, affective, and psychomotor abilities after participating in learning activities. According to Imansari & Sunaryantiningsih (2017), learning outcomes are often used as a measure to evaluate the extent to which an individual understands the material that has been taught (Al Fasha et al., 2023). Learning outcomes represent the specific abilities or skills in cognitive, affective, and psychomotor aspects that students have successfully achieved or mastered after undergoing the learning process (Gunawan & Zinnurain, 2019).

In reality, many students in schools still struggle to understand mathematics, leading to a decline in their interest in the subject. Mathematics is often perceived as a difficult and less engaging subject. Most students face challenges in understanding concepts and performing calculations. These difficulties can be caused by various factors, one of which is the teaching methods used by teachers. As a result, students' learning outcomes tend to be low.

Based on the observations conducted through interviews with teachers at SMP Negeri 1 Kediri, one of the mathematics teachers stated that the teaching process has not yet been optimized in utilizing and integrating technology-based media. In classroom instruction, many teachers still rely on conventional teaching methods, primarily using lectures and textbooks as the main teaching materials. This approach tends to make learning less engaging, leading to student boredom. Some teachers have started incorporating learning media such as PowerPoint presentations and instructional videos. However, the media used remains relatively basic. Even though computers are utilized, the materials still rely heavily on text, making the learning experience less interactive and engaging. The lack of a stimulating classroom environment further contributes to students' difficulties in understanding the material, ultimately leading to a decline in their learning outcomes.

Based on the data and information obtained through interviews with mathematics teachers at SMP Negeri 1 Kediri, students' mathematics learning outcomes have not yet been optimal. Many students have not met the Criteria for Learning Achievement (KKTP). This can be observed from the students' End-of-Semester Exam scores, where the KKTP set by the school is 71, as shown in Table 1 below.

Table 1. Final Semester Exam Results of Grade VII Students at SMP Negeri 1 Kediri for the 2023/2024 Academic Year

No	Class	Number of Students	Average Score	Classical Mastery
1	VII A	33	69,72	42%
2	VII B	33	67,96	39%
3	VII C	33	68,63	45%
4	VII D	32	66,93	34%
5	VII E	32	66,96	37%
6	VII F	32	65,28	31%
	Overall Average		**67,58**	**38%**

Based on the odd semester final exam score data for Grade VII students at SMP Negeri 1 Kediri in the 2023/2024 academic year, it shows that some students have not yet met the KKTP set by the school, which is a score of 71, with the classical mastery percentage also set at 85%. The data indicates that the classical mastery percentage is still far from the target set by the school.

One of the mathematics teachers at SMP Negeri 1 Kediri considers that this situation requires improvements in the learning process. One of the key improvements that teachers need to implement is adopting learning strategies that align with technological advancements by selecting appropriate learning media. One effective approach is using technology-based learning media to explain material to students, making it easier to understand and ultimately improving their learning outcomes. According to Nurrita (2018) and Yustiqvar et al. (2019), learning media can enhance students' learning outcomes. The use of learning media makes the teaching and learning process more engaging and accessible, allowing students to better understand and grasp the material in a more concrete manner.

Learning media serve as tools that support the effectiveness and efficiency of the teaching and learning process, making the conveyed messages clearer and helping achieve educational goals (Hadisaputra et al., 2019). Learning media can take various forms, one of which is instructional videos.

Instructional videos are media that utilize both audio and visual elements to capture students' attention, making them an effective learning tool. This aligns with the statement by Ariyanti and Sulisworo (2019), which highlights that the use of instructional videos is highly engaging and effective when implemented as a learning medium in the classroom. Through instructional videos, students can enhance their listening and visualization skills.

Teachers need to understand and develop TPACK skills to integrate technological and informational knowledge into the learning process. Technological Pedagogical and Content Knowledge (TPACK) is a conceptual framework that describes the relationship between three essential areas of knowledge that teachers must possess: technology, pedagogy, and content (Farikah & Al Firdaus, 2020). Improving teacher quality in the learning process can be achieved through TPACK integration. Wijaya et al. (2020) concluded that the implementation of learning media based on the TPACK framework has been proven to increase student participation in classroom learning activities.

TPACK is the knowledge that teachers must master to integrate technology, pedagogy, and content effectively and efficiently in the learning process. To present engaging material, learning media such as instructional videos can be used. Instructional videos combine audio and visual elements to capture students' attention, making them an efficient learning tool that enhances the quality of education and maximizes student learning outcomes. According to Afsari et al. (2022), the use of TPACK-based instructional videos falls into the excellent and effective category, improving student learning achievement by 88.25%.

Method

This type of research is experimental research. The method used is a Quasi-Experimental Design, with the specific research design being the Nonequivalent Control Group Design, as presented in Table 2.

Table 2. ***Nonequivalent Control Group Design Scheme***

Kelas	***Pretest***	***Treatment***	***Posttest***
Experimental	0_1	X	0_2
Control	0_3	-	0_4

(Sugiyono, 2018:345)

The study was conducted in classes VIIIC and VIIIE at SMPN 1 Kediri during the first semester of the 2024/2025 academic year. The research population consisted of all eighth-grade students at SMPN 1 Kediri. The sampling technique used was purposive sampling. Data collection techniques included tests, observations, and documentation. The type of questions used was essay questions. To determine the validity of the instrument, a content validity test was conducted using Aiken's V formula, with validation carried out by five experts: three Mathematics Education lecturers from FKIP Universitas Mataram and two mathematics teachers from SMPN 1 Kediri. The calculation results indicated that the instrument was valid and suitable for use. The data analysis techniques included normality testing, homogeneity testing, and hypothesis testing. Hypothesis testing was conducted using the N-Gain test and the *Independent Sample t-Test.*
The N-Gain criteria can be seen in Table 3 below.

Table 3. N-gain Criteria

N-gain Value $< g >$	Criteria
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

(Hake, 1999:34)

Result and Discussion

The implementation of this study was carried out in accordance with the Teaching Module, which was designed based on the curriculum, learning objectives, and learning outcomes. Before the learning process began, students were given a pretest to assess their initial abilities. After administering the pretest, the first and second learning sessions took place. During these two sessions, the experimental and control classes received different treatments. The experimental class was taught using TPACK-integrated learning media, while the control class was taught without the use of TPACK-integrated learning media. After completing all sessions, students were given a posttest to measure their learning outcomes following the treatment in the learning process.

The pretest and posttest data were subjected to hypothesis testing to determine the effectiveness of using TPACK-integrated learning media on students' learning outcomes in exponentiation in Grade VIII at SMP Negeri 1 Kediri during the 2024/2025 academic year. Before conducting the hypothesis test, prerequisite tests, including normality and homogeneity tests, were performed.

For the normality test, the *Kolmogorov-Smirnov* test was used with the assistance of SPSS software. After performing the normality test using the Kolmogorov-Smirnov test in SPSS, the results were obtained as shown in Table 4.

Table 4. Normality Test Result

Tests of Normality

		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
NGain_Score	Experimental Class	.089	28	.200*
	Control Class	.087	27	.200*

Based on Table 4, the data is normally distributed since the significance values for both the control and experimental classes are greater than 0.05 ($sig. > 0.05$). The significance values obtained for the control and experimental classes are both 0.200. Next, a homogeneity test will be conducted.

The homogeneity test is performed using a variance test with the assistance of SPSS software. After conducting the homogeneity test using the variance test in SPSS, the results were obtained as shown in Table 5.

Table 5. Homogeneity Test Result

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Ngain Score	Based on Mean	2.843	1	53	.098
	Based on Median	2.758	1	53	.103
	Based on Median and with adjusted df	2.758	1	45.990	.104
	Based on trimmed mean	2.815	1	53	.099

Based on Table 4, the data is homogeneous since the significance value is greater than 0.05, specifically 0.098 > 0.05. To evaluate the effectiveness of students' learning outcomes, the N-Gain test and the Independent Sample t-Test will be used to determine whether there is a significant difference between the control and experimental classes in terms of learning outcomes.
The following are the steps of data analysis conducted to assess the effectiveness of this study:

N-Gain Test

The N-Gain test is conducted by calculating the difference between pretest and posttest scores. The N-Gain Score was calculated using SPSS software. Below are the results of the N-Gain Score test in this study:

Table 6. N-Gain Score Test Results

Descriptives

	Class		Statistic	Std. Error
Ngain Score	Exerimental	Mean	.7342	.02883
		Median	.7386	
		Std. Deviation	.15256	
		Minimum	.34	
		Maximum	1.00	
		Range	.66	
	Control	Mean	.4180	.04347
		Median	.4048	
		Std. Deviation	.22585	
		Minimum	-.06	
		Maximum	1.00	
		Range	1.06	

Based on the N-Gain Score test results in Table 6, it can be seen that the average N-Gain Score for the control class is 0.4180**,** which falls into the medium category for learning improvement. Meanwhile, the mean N-Gain Score for the experimental class is 0.734**,** which, based on the N-Gain Score category, is classified as high in terms of learning improvement. This indicates that there was an increase in students' learning outcomes after being given treatment in the form of TPACK-integrated learning media. This finding aligns with the study by Afsari et al. (2022), which states that the use of TPACK-based learning media falls into the very good and effective category for improving students' learning achievement. Additionally, research by Irawan (2022) confirms that the TPACK approach is effective for use in learning and can enhance students' learning outcomes. Furthermore, Avissa et al. (2023) found that the application of TPACK in mathematics learning, particularly on the topic of fractions, is effective for classroom implementation.

Independent Sample t-Test

This test is conducted to determine whether there is a significant difference between the control and experimental classes in terms of learning outcomes. The SPSS program is used to conduct the Independent Sample t-Test. The test results for the control and experimental classes are presented in Table 7.

Tablel 7. Average N-Gain Score

Group Statistics

	Class	N	Mean	Std. Deviation	Std. Error Mean
NGain Score	Experimental Class	28	.7342	.15256	.02883
	Control Class	27	.4180	.22585	.04347

Based on Table 7, it can be seen that the mean or average N-Gain score of the control class is 0.4180, while the average N-Gain score of the experimental class is 0.7342.

Table 8. Independent t-Test Result

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
NGain Score	Equal variances assumed	2.843	.098	6.104	53	.000	.316	.051	.212	.420
	Equal variances not assumed			6.062	45.442	.000	.316	.052	.211	.421

To determine the results of the independent t-test, refer to Table 8, where the calculated t-value (t_{hitung}) is 6.104, while the critical t-value (t_{tabel}) is 2.005 (based on the t-student distribution table). According to the decision rule and the results of the Independent Sample t-test, since $t_{hitung} > t_{tabel}$, the alternative hypothesis (H_a) is accepted, and the null hypothesis (H_0) is rejected. Therefore, it can be concluded that there is a significant difference in effectiveness between the experimental and control classes. This finding aligns with the study by Mishra & Koehler (2006), which states that students learning with TPACK-based instructional media show higher learning gains because this approach optimizes technology, pedagogy, and content compared to students who do not use TPACK-integrated instructional media. A previous study that also examined differences in learning outcomes between the control and experimental groups was conducted by Aprelia (2022), which found that there was a difference in learning outcomes between classes using the Scientific TPACK learning approach and those that did not.

Conclusion

Based on the results of the study and the discussion presented, it can be concluded that the use of TPACK-integrated learning media is effective in improving students' learning outcomes on exponentiation material for eighth-grade students at SMP Negeri 1 Kediri in the 2024/2025 academic year. This is evident from the increase in learning outcomes in the experimental class, with an N-Gain Score index of 0.7342, which falls into the high category, while the control class has an N-Gain Score of 0.4180, which falls into the medium category. Additionally, there is a significant difference between the average mathematics learning outcomes of the experimental and control classes, as indicated by the results of the independent sample t-test, where $t_{hitung} > t_{tabel}$ or 6.104 > 2.005.

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