

The Effect of Interactive Mathematics Learning Media to Improve Students' Learning Independence

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Abstract

Learning independence is one of the important abilities that students must have in learning mathematics. However, the level of student learning independence still needs to be improved through the use of innovative learning media. This study aims to determine the effect of interactive mathematics learning media on student learning independence. This study used a quantitative approach with a One Group Pretest–Posttest design. The research sample consisted of 15 students of the Mathematics Education Study Program, Nahdlatul Ulama University, Lampung. Data were collected using a learning independence questionnaire consisting of 25 statements. Data analysis included descriptive statistics, N-Gain, and Effect Size (Cohen's *d*). The results showed that all indicators of learning independence increased after the use of interactive learning media. The N-Gain value of 0.5198 is included in the moderate category, while the Effect Size value indicates a large influence. Thus, interactive mathematics learning media is effective for improving student learning independence.

Keywords

Interactive Learning Media; Independent Learning; Mathematics Education; Undergraduate Students.



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INTRODUCTION

The development of information and communication technology has brought significant changes to various aspects of life, including education. Digital transformation is driving a paradigm shift in learning from teacher-centered to student-centered learning (Togatorop et al., 2025). In this context, the use of technology is not only a tool but also a means to create more effective, interactive, and meaningful learning experiences (Sulistiyowati & Asriati, 2024).

In line with these developments, the application of technology in education has introduced various learning innovations that support a more dynamic learning process. Various digital platforms, learning applications, and interactive media are now being utilized to facilitate material delivery, increase student participation, and provide a more engaging learning experience (Nasir & Wazithah, 2025). The use of technology also allows

students to gain flexible access to various learning resources, thus supporting more independent, collaborative learning, and oriented towards the development of 21st-century skills (Hakim & Rahmadini, 2025).

Learning mathematics, as a field of study characterized by its abstract and complex nature, requires an innovative approach. Students are required not only to understand concepts but also to apply and analyze them independently (Khusna & Miatun, 2023). Therefore, the use of interactive learning media is one solution that can help visualize abstract concepts, making them easier to understand (KW Saputra et al., 2024).

Interactive learning media allows students to actively engage in the learning process through various features such as animations, simulations, practice exercises, and immediate feedback. This aligns with recent research findings that suggest interactive media can increase student engagement (Topano et al., 2022). Furthermore, interactive media has also been shown to increase learning motivation and provide a more engaging and less monotonous learning experience (Aprianto & Wahyudin, 2023).

Other research shows that the use of interactive multimedia can improve students' self regulated learning by providing opportunities for students to learn at their own pace and learning style (RY Saputra & Alexon, 2023). In fact, a recent study found that interactively designed digital learning media can improve students' learning outcomes and critical thinking skills (Meiriza et al., 2025).

The Differential Equations course, taught in the sixth semester of the Mathematics Education Study Program at Nahdlatul Ulama University, Lampung, is one of the most challenging courses. The material presented requires not only mathematical analysis skills but also logical, systematic, and in-depth thinking. This often presents a challenge for students in understanding the concepts comprehensively.

Based on initial observations, it was found that most students still had difficulty understanding the Differential Equations material. Students tended to rely on lecturers' explanations and lacked the initiative to study independently. This situation indicates that students' self regulated learning still needs to be improved. Furthermore, web-based media, accessible to all students, has been utilized in the learning process. This media is used for delivering materials, assignments, and learning communication. However, in practice, this media has not been fully functional in supporting the learning process.

A frequently encountered problem is difficulty accessing websites, either due to limited internet connections or unstable system performance. As a result, students cannot access materials consistently, hindering the learning process and reducing learning effectiveness. This situation demonstrates that the use of digital media is not necessarily effective without adequate accessibility.

Learning independence is a crucial competency for students, especially in facing the challenges of 21st-century learning (Huda et al., 2026). Students with high levels of learning independence are able to organize learning strategies, demonstrate initiative, discipline, and

take responsibility for their learning outcomes (Paseleng et al., 2022) . Therefore, learning innovations are needed to foster this independence.

One such innovation is the use of interactive learning media that is more flexible, engaging, and easily accessible. This includes Android-based interactive learning media that can be accessed online. According to R. Y. Saputra & Alexon, (2023), Android-based interactive media has been shown to enhance learning independence. Supported by research by Hanafi & Samsudin, (2012), which shows that Android-based learning applications are very well received by students due to their interactivity, ease of access, and flexibility in supporting learning. The use of interactive learning media is expected to not only improve student understanding of the learning material but also encourage the development of independent learning through opportunities for flexible, active, and student-centered learning.

This research is still limited in its use of interactive learning media at the university level, particularly in abstract mathematics courses such as Ordinary Differential Equations. Based on this description, this study aims to analyze the effect of interactive mathematics learning media on improving student independent learning in the sixth semester Differential Equations course in the Mathematics Education Study Program at Nahdlatul Ulama University, Lampung. The results of this study are expected to contribute to the development of learning innovations and serve as a reference for improving the quality of mathematics learning in universities.

METHODS

This study uses a quantitative approach with a quasi-experimental method (*pre-experimental design*) through a *One Group Pretest-Posttest design*. The aim was to determine the effect of interactive mathematics learning media on students' learning independence. This design involved one group of subjects given a pretest before treatment and a posttest after treatment, allowing for direct measurement of changes. The study subjects were 15 sixth-semester students in the Mathematics Education Study Program at Nahdlatul Ulama University, Lampung, using a saturated sampling technique. Data collection included a learning independence questionnaire (pretest and posttest) and observations as supporting data. This approach is considered effective in measuring the effect of the treatment in the learning context, particularly in mathematics education research.

The research instrument was a learning independence questionnaire consisting of 25 items using a five-level Likert scale: Strongly Agree (SS), Agree (S), Undecided (R), Disagree (TS), and Strongly Disagree (STS). The instrument was developed based on the Self-Regulated Learning theory proposed by (Triana et al., 2026; Zimmerman, 2002) which includes seven indicators: learning initiative, learning planning and strategies, self-management, self-efficacy, monitoring and strategy use, utilization of learning resources, and reflection and self-evaluation.

The research procedure began with a pretest using a learning independence questionnaire to determine the students' baseline conditions. Next, the students participated in two sessions of interactive mathematics learning media in accordance with the Semester Learning Plan (RPS). After the entire learning process was completed, the students completed the posttest questionnaire to determine changes in their learning independence levels after using the interactive learning media.

To determine the extent of improvement in students' learning independence after the treatment, a Normalized Gain (N-Gain) analysis was conducted using the formula (Hake, 1999). This analysis, which had previously been performed on descriptive statistics, described the students' learning independence scores through minimum, maximum, average (mean), standard deviation, and percentage achievement for each indicator. Furthermore, a normality test was conducted using Shapiro–Wilk because the sample size was less than 50 respondents. Data were declared normally distributed if the significance value (Sig.) was greater than 0.05. Hypothesis testing was conducted using the Paired Sample t-Test to determine the difference in the level of student learning independence before and after the use of interactive learning media. The hypothesis was accepted if the Sig. (2-tailed) value < 0.05 , which indicates a significant difference between the pretest and posttest scores following the following criteria:

Tabel 1. Criterion Interpretation *N-plus*

N- plus	Interpretation Criteria
$g > 0.7$	Height
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

In addition, to determine the magnitude of the influence of the use of interactive learning media on improving student learning independence, the Effect Size (Cohen's d) was calculated. The effect size value was interpreted into small ($d = 0.20$), medium ($d = 0.50$), and large ($d \geq 0.80$) categories (Lakens, 2013). The combination of the statistical test results was used as a basis in explaining the influence of interactive mathematics learning media in improving student learning independence.

FINDINGS AND DISCUSSION

Findings

This study involved 15 Mathematics Education students taking the Ordinary Differential Equations course. The following are the *pretest* and *posttest percentage results* for each indicator:

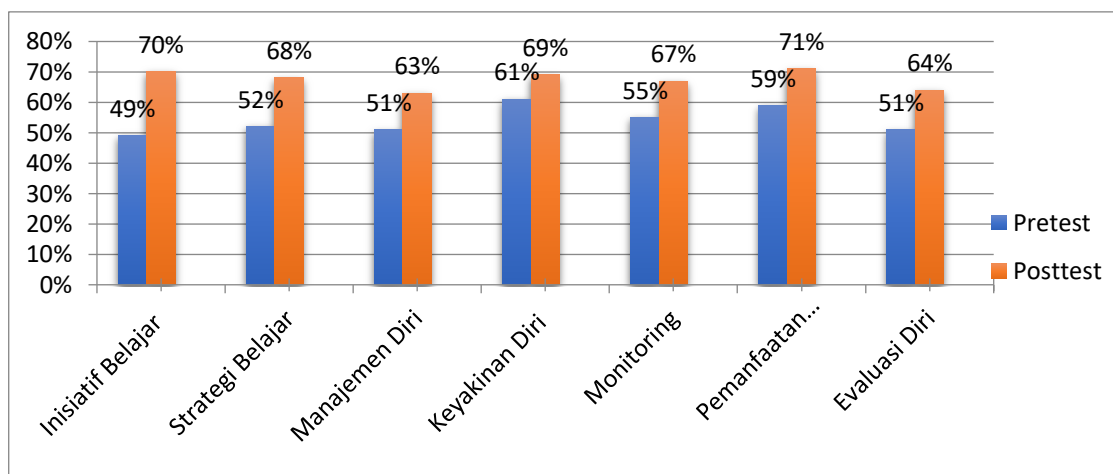


Figure 1. Results of the *pretest* and *posttest* percentages for each indicator

Figure 1 shows a comparison of the percentage of student learning independence levels before (*pretest*) and after (*posttest*) using interactive mathematics learning media for each indicator of learning independence. In general, all indicators have increased after implementing interactive learning media, which shows that the media developed is able to make a positive contribution to increasing student learning independence.

In the learning initiative indicator, the percentage increased from 49% in the *pretest* to 70% in the *posttest*, or an increase of 21 percentage points. These results indicate that the use of interactive learning media encourages students to be more active in starting the learning process independently without depending on the lecturer's direction.

Planning and learning strategy indicators also increased from 52% to 68%, while self-management increased from 51% to 63%. An increase in these two indicators indicates that interactive learning media helps students plan learning activities, choose appropriate learning strategies, and manage study time more effectively. The self-efficacy indicator increased from 61% to 69%. Even though the increase is relatively smaller compared to other indicators, these results show that students become more confident in solving mathematical problems after gaining learning experience using interactive media.

Monitoring and strategy use indicators increased from 55% to 67%, while learning resource utilization indicators increased from 59% to 71%, which is the highest *posttest* score among all indicators. These findings show that interactive learning media is able to encourage students to utilize various learning resources, such as digital materials, learning videos, and interactive exercises, so that the learning process becomes more independent and student-centered.

Meanwhile, reflection and self-evaluation indicators increased from 51% in the *pretest* to 64% in the *posttest*. This increase shows that students are getting used to evaluating learning outcomes, recognizing their weaknesses, and trying to improve learning strategies after receiving feedback from the learning process.

Overall, the average percentage of learning independence increased from around 54% on the pretest to around 67% on the posttest, or an increase of 13 percentage points. These findings indicate that the use of interactive mathematics learning media has a positive influence on increasing student learning independence in all aspects measured. This increase is in line with the theory of Zimmerman (2002) which states that learning media that provide opportunities for students to regulate their own learning process can improve self-regulated learning abilities, including aspects of planning (forethought), implementation (performance), and reflection (self-reflection).

Thus, interactive learning media not only acts as a means of delivering material, but also as a facilitator who encourages students to learn more independently, actively and responsibly for their learning process. Next, to determine the level of increase in student learning independence after treatment, an analysis was carried out using Normalized Gain (N-Gain) using SPSS 25. The average value obtained was 0.5198, which is included in the medium category. These results show that the use of interactive mathematics learning media is able to increase student learning independence effectively.

This increase indicates that students are better able to organize their learning process, utilize learning resources independently, and reflect on learning outcomes after participating in interactive media-based learning. Apart from testing significance, this research also calculated the Effect Size (Cohen's d) to determine the magnitude of the influence of the use of interactive learning media on student learning independence. By using the website <https://effectsize.science/> we obtained $d = 4.66$, which is included in the large category. This shows that the use of interactive mathematics learning media not only makes a statistically significant difference, but also has a strong influence on increasing student learning independence.

These findings indicate that interactive learning media is able to create a learning environment that encourages students to be more active in planning, monitoring and evaluating their learning process. Thus, interactive learning media can be an effective learning alternative in increasing student learning independence in mathematics courses.

Discussion

The research results indicate that the use of interactive mathematics learning media can improve students' learning independence. The results showed an increase in each indicator, reinforced by an overall increase in learning independence. The N-Gain analysis showed a moderate increase, and the Effect Size (Cohen's d) value indicated a large effect of interactive learning media on learning independence. Thus, interactive learning media not only produced statistically significant differences but also had a strong practical impact on improving students' learning independence. These findings indicate that the use of interactive learning media can encourage students to be more active in managing their learning process, increase responsibility for academic assignments, and build confidence in understanding mathematics material.

Interactive learning media provides students with opportunities for independent learning through systematic presentation of material, interactive practice problems, direct feedback, and evaluations that can be completed at any time. These characteristics create a more flexible learning experience, eliminating the need for students to rely solely on lecturer explanations during lectures. Furthermore, interactive media allows students to review material as needed, improving their understanding of mathematical concepts and contributing to increased learning independence.

The findings of this study align with those of Hendrik et al., (2021), who stated that the implementation of technology-based learning through blended learning can gradually increase student learning independence because students have greater opportunities to regulate their own learning strategies.

These findings are also supported by research by Lestari & Nurafifah, (2021), who showed that the implementation of hybrid lectures based on self-regulated learning strategies can increase the learning independence of prospective mathematics teachers. Students become more responsible for planning, monitoring, and evaluating their learning process when supported by student-centered learning media and strategies.

This study also aligns with the findings of Sukmawati et al., (2023), who stated that interactive web-based learning media is considered valid, practical, and effective for use in mathematics learning because it increases student engagement during the learning process. Interactive media not only facilitates the delivery of material but also provides a more engaging learning experience, encouraging students to learn actively and independently.

Furthermore, the results of this study are supported by research by Tambunan et al., (2024), which found that independent learning has a positive and significant impact on student learning outcomes. Students with high levels of independent learning tend to demonstrate better academic abilities than those with low levels.

Therefore, enhancing independent learning through the use of interactive learning media is one strategy that can support the improvement of the quality of mathematics learning in higher education. Based on the overall results of this study and support from previous research, it can be concluded that interactive mathematics learning media is an effective learning innovation in enhancing independent learning in students. Media that combines visual elements, audio, interactive exercises, and direct feedback can create student-centered learning. Thus, students not only gain an improved understanding of mathematics material but also develop the ability to manage their learning process independently, a crucial competency in higher education in the digital age.

CONCLUSION

Based on the research results, it can be concluded that the use of interactive mathematics learning media has a positive influence on increasing students' learning independence. This improvement is seen in all indicators of learning independence, indicating that interactive learning media can encourage students to be more active in planning, implementing, and

evaluating their learning process independently. In addition, interactive learning media also helps students utilize various learning resources, increases self-confidence in solving mathematical problems, and fosters responsibility for the learning process. Thus, interactive mathematics learning media can be an effective learning alternative to support the development of student learning independence in higher education. Further research is recommended to involve a larger number of respondents and use a research design involving a comparison group so that the effectiveness of learning media can be studied more comprehensively.

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