

Improving vocational high school students' mathematics achievement by integrating differentiated instruction through Nearpod

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Abstract: Education is one of the key aspects that can determine whether a nation advances or not. However, Indonesian students' learning outcomes in numeracy indicators are still relatively low. Teachers need to prepare new learning strategies and create a learning atmosphere that is enjoyable, creative, and skill oriented. This study aims to describe the effect of integrating differentiated learning through Nearpod on vocational high school students' learning outcomes. The method used is a quasi-experimental design with a pre-experimental one-group pretest-posttest approach. The population consisted of 2,027 students, and the sample included 35 students selected using purposive sampling. Data analysis techniques employed the Independent Sample T-Test. The results showed that the integration of differentiated learning through Nearpod had a significant effect on the learning outcomes of vocational high school students. There was an increase in the average posttest scores of students after receiving mathematics instruction using differentiated learning supported by the gamified Nearpod application. These findings support the importance of integrating differentiated learning through Nearpod to improve student learning outcomes and build quality education.

Keywords:

Differentiated Learning, Gamification, Learning Outcomes, Learning Readiness, Nearpod.

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1. Introduction

Education is one of the key factors that determine whether a nation progresses. If the quality of education is good, it will have a positive impact on the nation. Conversely, poor quality of education will also negatively affect the nation (Schunk, 2012). Quality education gives rise to innovation, creativity, and continuous improvement from generation to generation. As a developing country, Indonesia should place greater emphasis on the field of education. Education in Indonesia is part of efforts to enlighten national life and improve the quality of human resources (Aningsih et al., 2022; Ishartono et al., 2024).

The quality of education can be seen in its learning system. Learning is a teaching and learning process between teachers and students aimed at achieving academic success. Learning is considered successful when students can understand what they have learned (Purwitaningrum & Prahmana, 2021; Sembiring et al., 2008). However, the results of the 2021 AKM (National Assessment) showed that Indonesian students' learning outcomes in numeracy indicators remain low, with an average score of 41.12. One effort that can be made to ensure the learning process aligns with educational objectives is to engage students actively and creatively, enabling them to formulate and discover their own learning (Ulfah et al., 2023; Wijaya et al., 2024).

According to Nugroho (2024), teachers must also be able to balance the individual needs of learners with diverse learning methods, while still aligning with curriculum demands and broader learning goals. A teacher must also understand students' characteristics, interests, and learning abilities. Every student has different interests and levels of comprehension—some grasp lessons quickly, while others struggle to understand what the teacher delivers. If a teacher is not creative in delivering the subject matter, the learning objectives will not be achieved. Before conducting lessons, a teacher must plan learning activities and determine the appropriate teaching strategy. Choosing the right learning strategy can make it easier for students to understand the material. A learning strategy is a plan of action that includes methods and resources used in the learning process (Nugroho, Desti, et al., 2025). Based on these issues, there is a need for new learning strategies that foster an enjoyable, creative, and skilled learning environment. Differentiated learning strategies can be used by educators to make the teaching and learning process more active and enjoyable.

Differentiated learning is an adjustment to students' interests, learning preferences, and readiness in order to improve learning outcomes (Kirschner et al., 2011; Mohamad et al., 2024). These adjustments relate to students' interests, learning profiles, and readiness to help enhance their academic achievement. According to Tomlinson (2014), differentiated learning is the effort to tailor the classroom learning process to meet students' individual learning needs. It accommodates, serves, and recognizes students' diversity in readiness, interests, and learning preferences (Hudson, 2007; Lee & Johnston, 2024; Sinha et al., 2021). Differentiated learning is also defined as a method of identifying and teaching students based on their differing talents and learning styles (DEMİR, 2021).

Differentiated learning emphasizes the concept that each individual has different interests, potentials, and talents. Therefore, the teacher's role is to coordinate and integrate these differences using appropriate strategies. In conclusion, differentiated learning is an approach tailored to students' learning needs, interests, and abilities. Tomlinson (2014) outlines three key elements of differentiation in learning: (1) content differentiation, which refers to what students learn in relation to the curriculum and subject matter; (2) process differentiation, which refers to how students process ideas and information, including how they choose their learning styles; and (3) product differentiation, which refers to how students demonstrate what they have learned.

According to Tomlinson (2014), categorizing students' learning needs should at least consider three aspects: (1) readiness, which is the capacity to learn new material; (2) student interest, which is a key motivator for active participation in the learning process; and (3) learning profile, which involves various factors such as language, culture, health, family background, and other specific characteristics. This is also related to a person's learning style. The goal of mapping students' learning needs is to give them the opportunity to learn in a natural and efficient way. For example, teachers may sometimes, unintentionally, favor a learning style that aligns with their own, even though each student may have different conditions and tendencies. Being aware of this is essential so that teachers can vary their methods and approaches accordingly.

In practice, students are often still focused on memorizing formulas and solving problems without truly understanding the concepts. Teachers tend to use lecture methods, which are considered dull and rarely involve engaging learning media. In fact, mathematics should be delivered using contextual problems and real-world scenarios to help students grasp the material more easily. Students often dislike mathematics because they find it boring and it makes them sleepy, largely due to unengaging teaching methods that fail to capture their attention (Nugroho et al., 2024; Nugroho, Sugiman, et al., 2025). Furthermore, vocational high school students often feel that mathematics is not useful for their lives (Kummanee et al., 2020; Sirakaya & Kilic Cakmak, 2018).

Mathematics frequently involves abstract concepts that are difficult to grasp through verbal explanation alone. Digital literacy can assist students in understanding mathematics by turning it into practical games, competitions, and practice sessions (Clark et al., 2020; Olive et al., 2009). Digital technology enables the visualization of mathematical concepts through graphs, animations, and other visual demonstrations, which can help students gain a better understanding. Additionally, digital technology can be tailored to individual students' needs, allowing each student to access learning materials that match their level of understanding and learning pace, resulting in a more effective and efficient learning experience. One widely used technology in education is Nearpod. In studies by Elizabeth Freire Espin & Marcelo Rodriguez Cortez (2022) and Hernandez-Mena et al. (2024), the results showed that using Nearpod within the discovery learning model was highly feasible and effective in improving students' critical thinking skills.

Based on the above background, the research question is: How does integrating differentiated learning through Nearpod affect the learning outcomes of vocational high school students? Therefore, this study aims to answer that question by describing the impact of integrating differentiated learning through Nearpod on vocational high school students' learning outcomes.

2. Methods

In accordance with the problem being studied, the type of research used is classified as quasi-experimental with a pre-experimental one-group pretest-posttest design involving one class. The subjects were assigned to an experimental group and given a pretest, then received

treatment over a specified period, after which the dependent variable was measured via a posttest. This research was conducted at a vocational high school that implements the latest Indonesian curriculum, located in the Central Java area, and allows students to bring mobile devices. The study population comprised 2,027 students, and the sample was selected through purposive sampling, yielding 35 students. The research was carried out in October 2023. All students involved voluntarily agreed to participate in this research.

The instruments used for data collection were pretest and posttest assessments of students' learning outcomes. These instruments underwent validity and reliability testing to ensure they accurately represented the data. Content validity was assessed by at least three validators, and their evaluations were analyzed using Aiken's V. According to Retnawati (2016), an item is considered valid and usable if its Aiken's index score is greater than 0.4. Subsequently, the instruments were tested and their reliability was calculated using the Cronbach's Alpha formula. Retnawati (2016) states that an instrument is considered reliable if its reliability index is $\geq 0,7$. Once the instruments are confirmed to be valid and reliable, they can be used in the study.

The research activities began with a pretest administered during the first session to assess students' initial understanding of the prerequisite material. After the pretest, the results were analyzed to map student groups by learning readiness. The criteria for grouping students according to learning readiness were based on score interpretation using norm-referenced criteria, as shown in Table 1 (Retnawati, 2016). Instructional activities began in the following session, during which students learned through Nearpod, with differentiation based on their learning readiness (see Figure 1).

Table 1. Students' Learning Readiness Criteria

Learning Readiness Criteria	Descriptions
$x > \bar{x} + 0,5SD$	Complete Understanding
$\bar{x} - 0,5SD \leq x \leq \bar{x} + 0,5SD$	Partial Understanding
$x < \bar{x} - 0,5SD$	No Understanding

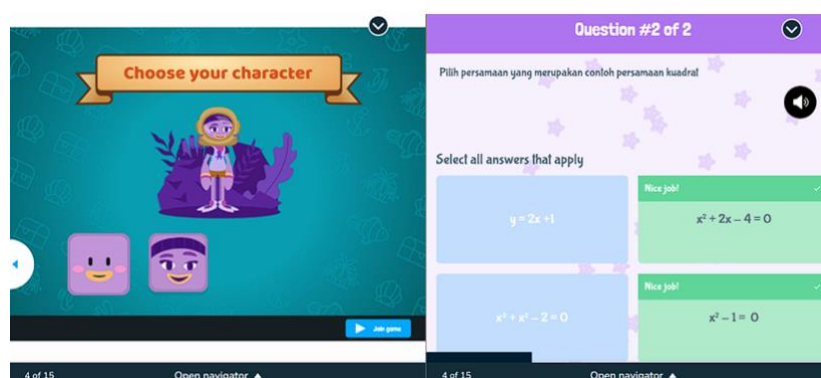


Figure 1. The Use of Nearpod in Differentiated Instruction Based on Learning Readiness

Next, data analysis was conducted using IBM SPSS 25 with a significance level of $\alpha = 5\%$. First, a normality test was carried out to determine whether the data followed a normal distribution. If the data were normally distributed, the analysis continued with an Independent Samples T-Test to examine whether differentiated instruction through Nearpod had a more positive effect on vocational high school students' learning outcomes. However, if the data were not normally distributed, the hypothesis would be tested using the Mann-Whitney test. Based on the points described above, the hypothesis proposed in this study is: The implementation of differentiated learning through Nearpod has a more positive effect as measured by the average learning outcomes of vocational high school students.

3. Results and Discussion

The research instruments were tested for validity and reliability to ensure they could represent valid data. The results showed that both the pretest and posttest instruments were valid and reliable. A pretest was then conducted to assess students' initial abilities and to map them based on their learning readiness. The analysis of students' learning readiness (see Table 2) showed that 48.57% of students had no understanding, 34.29% had partial understanding, and 17.14% had full understanding. The experimental procedure was then carried out in accordance with the learning steps described earlier.

Table 2. Analysis of Students' Learning Readiness

Group	Sum	Percentage
No Understanding	17	48,57%
Partial Understanding	12	34,29%
Complete Understanding	6	17,14%

Based on the results of the pretest and posttest measuring students' critical thinking abilities, descriptive statistics were obtained as shown in Table 3. The pretest results showed a highest score of 90, a lowest score of 20, and an average score of 46.86. In contrast, the posttest results showed a highest score of 100, a lowest score of 60, and an average score of 88.23.

Table 3. Descriptive Statistic

Data	Score		Average
	Min	Max	
Pretest	20	90	46,86
Posttest	60	100	88,23

Before conducting hypothesis testing to determine whether the implementation of differentiated instruction through Nearpod has a more positive effect based on the average learning outcomes of vocational high school students, it is necessary to first perform a normality assumption test with the Shapiro-Wilk. If the sample comes from a normally

distributed population, the hypothesis test can be carried out using the Independent Samples T-Test. However, if the data do not come from a normally distributed population, the appropriate test is the Mann-Whitney test. The normality test was conducted using IBM SPSS 25, and the results obtained are as follows.

Table 4. Normality Test Result

Group of Sample	Statistic	df	Sig.
Pretest	0.134	35	0.115
Posttest	0.128	35	0.158

By using a 5% significance level, the test statistic for the pretest was 0.134 with a significance value (sig.) of 0.115. Since the sig. value $> \alpha = 0.05$, H_0 is accepted. In other words, the data are normally distributed, and the normality assumption is fulfilled. Additionally, the posttest yielded a test statistic of 0.128 with a significance value of 0.158. Again, since the sig. value $> \alpha = 0.05$, H_0 is accepted, indicating that the data are normally distributed, and the normality assumption is fulfilled. Therefore, the hypothesis testing was carried out using the Independent Samples T-Test.

The One-Tailed Test (Independent Samples T-Test) was conducted to determine whether the integration of differentiated instruction through Nearpod had a more positive effect on the learning outcomes of vocational high school students. This test was calculated using IBM SPSS 25, and the results can be seen in Table 5. The hypotheses used in this one-tailed test are as follows.

$H_0 : \mu_A > \mu_B$ (posttest results are better than pretest results)

$H_1 : \mu_A \leq \mu_B$ (posttest results are not better than pretest results)

with:

μ_A = average posttest score

μ_B = average pretest score

Table 5. One-Tailed Test Result

Result	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	Lower	Upper
Equal variances not assumed	2.119	35	.746	-20.657	3.376	-27.394	-13.920

By using a significance level of 5%, and since the population variances were not assumed to be equal, the t-test value used is from the Equal variances not assumed, which gives a $t_{value} = 2.119$, $df = 35$, and a sig. (2-tailed) value of 0.746. For the one-tailed test, the significance level is set at $\alpha = 0.05$. Since sig. > 0.05 , H_0 is accepted. This means there is a significant difference between pretest and posttest learning outcomes, indicating that the treatment had a significant positive effect.

Nugroho & Septianisha (2025) and Wilkie & Ayalon (2018) presented findings that align

with the results of this study, which show that when teachers give more attention to facilitating learning through differentiated instruction, students' thinking skills will subsequently develop. The improvement in students' thinking skills can be attributed to differentiated instruction (Al-Shehri, 2020). There is a positive correlation between students' thinking abilities and their learning outcomes (Kusmaharti & Yustitia, 2022; Net & Kusmaryono, 2023). The higher the students' thinking abilities, the better their learning outcomes. In other words, differentiated instruction has been proven effective in improving students' academic performance. This is because, through differentiation, students feel supported and more noticed by the teacher, which fosters their interest in learning. Additionally, learning becomes more engaging through gamified digital platforms such as Nearpod.

Nearpod supports interactive learning, enabling lessons that enhance mathematical skills. Hernandez-Mena et al. (2024) demonstrated in their study that students' understanding can be developed through the application's features, which make learning powerful, interactive, enjoyable, and meaningful. Furthermore, Nearpod can be integrated with other learning models such as discovery learning, following the flow of the respective model.

Not only is Nearpod suitable for in-person learning, but it can also be used in online learning by integrating it with video conferencing tools such as Zoom or Google Meet. Nearpod can be accessed without needing to install an app, and it is both user-friendly and convenient. (Elizabeth Freire Espin & Marcelo Rodriguez Cortez, 2022) analyzed the use of Nearpod in online mathematics learning in terms of ease of use and its performance in supporting interactive learning. The results showed that, in terms of ease, Nearpod is easily accessible via the web and the activities within it are simple to execute. In terms of performance, Nearpod has proven helpful in understanding the material being taught and is effective for online learning. Nearpod offers many features, many of which are especially beneficial for implementing assessment. The current curriculum includes three types of assessment: Diagnostic, Formative, and Summative. Therefore, Nearpod is very helpful in applying assessments without creating a stressful atmosphere.

The curriculum emphasizes meaningful learning, so features such as 3D, VR, and Simulation can make it easier for teachers to deliver material. In addition, the curriculum also highlights student-centered learning, where teachers can utilize discussion features such as Open-Ended, Collaborative Board, and others. Critical thinking skill assessment instruments based on Nearpod can be used in evaluation activities due to their high practicality (Ariyanti & Rahayu, 2025). Nearpod includes a gamification system, although it is limited to the Time to Climb feature. Other features can only detect correct or incorrect answers and immediately display the score. Gamification is the use of game elements to solve non-game problems, aiming to improve system performance by increasing motivation (Kummanee et al., 2020; Muangsrinoon & Boonbrahm, 2019). Abdul Rahman et al. (2018) and Pujiastuti et al. (2025) demonstrated that there was an improvement in students' learning outcomes due to the use of gamification in the assessment process of mathematics learning.

4. Conclusion

Based on the research findings above, it can be concluded that integrating differentiated instruction through Nearpod positively impacts the learning outcomes of vocational high school students. The features of Nearpod that are commonly used in mathematics learning include Time to Climb, Collaborate Board, and Open-Ended. Nearpod can be integrated with various instructional models, assessments, and learning approaches that incorporate gamification.

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