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EFFECT OF DIFFERENTIATED LEARNING BASED LEARNING STYLE ON LEARNING OUTCOME IV GRADE IN MATHEMATICS

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Abstract

Differentiated learning is a solution to the lack of attention to differences in learning styles among students, which results in unmet learning needs and suboptimal learning outcomes This study aims to examine the effect of different learning styles on the learning outcomes of fourth-grade elementary school students. The research method used is quantitative with a quasi-experimental design. The sample in this study consists of 31 fourth-grade elementary school students in Sendang Subdistrict, selected using purposive sampling. Data collection techniques used a test consisting of 20 multiple-choice questions based on cognitive levels C1-C6 of length measurement material. Data analysis used the Independent Sample T-Test. The research results showed that the p-value in the pretest and posttest was < 0.001, indicating a significant effect. This study concludes that differentiated instruction based on learning styles has a significant effect on the learning outcomes of fourth-grade students in mathematics. Differences in learning styles can be accommodated in the classroom learning process to meet the diverse needs of students and encourage high motivation to learn in order to achieve maximum academic results.

Keywords: *Differentiated Learning; Learning Outcome; Learning Style.*

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Abstrak

Pembelajaran berdiferensiasi hadir sebagai solusi atas kurangnya perhatian terhadap perbedaan gaya belajar peserta didik, yang menyebabkan kebutuhan belajar tidak terpenuhi dan hasil belajar kurang optimal. Penelitian ini bertujuan untuk menguji pengaruh gaya belajar yang berbeda terhadap hasil belajar siswa kelas IV sekolah dasar. Metode penelitian yang digunakan adalah kuantitatif dengan desain quasi-eksperimental. Sampel dalam penelitian ini terdiri dari 31 siswa kelas IV sekolah dasar di Kecamatan Sendang, yang dipilih menggunakan sampling purposif. Teknik pengumpulan data menggunakan soal tes yang terdiri dari 20 soal berbentuk pilihan ganda berdasarkan tingkat kognitif C1-C6 materi pengukuran panjang. Analisis data menggunakan Uji T Sampel Independen. Hasil penelitian menunjukkan bahwa nilai p pada pretest dan posttest adalah < 0,001, menunjukkan adanya pengaruh yang signifikan. Penelitian ini menyimpulkan bahwa pembelajaran yang dibedakan berdasarkan gaya belajar memiliki pengaruh yang signifikan terhadap hasil belajar siswa kelas IV pada mata pelajaran matematika. Perbedaan gaya belajar dapat diakomodasi dalam proses pembelajaran di kelas guna memenuhi kebutuhan siswa yang beragam dan mendorong motivasi belajar yang tinggi demi pencapaian hasil belajar yang optimal.

Kata Kunci: *Pembelajaran Berdiferensiasi; Gaya Belajar; Hasil Belajar.*

A. Introduction

Education is the main foundation in human life that serves to develop the potential of students as the nation's future generation (Putri, 2021). In the context of education, students are expected to develop themselves and achieve success through a quality learning process. The essence of education is not only limited to understanding material, but also includes the development of thinking, emotional, and physical skills (Ana & Astutik, 2024). In 21st-century education, there is an emphasis on developing skills relevant to global challenges and technological advancements, which drive innovation and creative thinking abilities (Muliastrini, 2020). Therefore, the learning system must be learner-centred to encourage their active participation and facilitate optimal understanding of the material.

According to Ki Hadjar Dewantara, education is a process that aims to develop the full potential of individuals in an optimal manner, with the ultimate goal of helping individuals achieve complete well-being and happiness, both as individuals and as members of society (Syahputri et al., 2023). This process involves continuous guidance and facilitation so that individuals can

reach their full potential. The realisation of this potential is inseparable from the learning process that is carried out. The learning envisioned by Ki Hadjar Dewantara requires recognition and respect for the diversity of potential and characteristics of each student. The principle of equality in education demands that teachers create an inclusive learning environment where every individual has equal opportunities to develop. This can be achieved, among other things, by implementing differentiated learning.

Differentiated learning is an important approach and way of thinking about the learning process in line with the current independent curriculum. The dominant learning styles among students, namely visual, auditory, and kinesthetic, require differentiation in teaching (Nawati et al., 2023). Differentiated instruction provides flexibility for teachers to adapt learning content, learning methods, and learning outcomes to suit the characteristics of each student (Fitriyah & Bisri, 2023). Learning styles are manifestations of how a person interacts with their learning environment. Internal factors such as cognitive characteristics and sensory preferences, as well as external factors such as learning experiences and social environments, collectively shape an individual's learning style. This diversity in learning styles underscores the importance of an individualised approach to learning to achieve optimal learning outcomes (Dalimunthe et al., 2022). Thus, students' understanding of the material improves while fostering their active participation during learning activities. Considering students' learning styles in teaching and learning activities can create a connection with the material, ultimately increasing their enthusiasm and self-confidence.

Student learning success is measured by learning outcomes. Learning outcomes are what students achieve after participating in the learning process. Learning outcomes demonstrate the ability and quality of the learning process undertaken by students (Choirina et al., 2024). The benefits of learning outcomes achieved by students are to determine the extent to which students can absorb the learning material, so that it can be used as a reference for evaluating future learning.

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Observations at one elementary school in Sendang District, Tulungagung, showed that many students faced difficulties in understanding mathematical concepts, resulting in low learning achievement (Setiani et al., 2022). A lack of interest and enthusiasm for learning causes students to tend to be inactive and unfocused during lessons. To address this, teachers need to design engaging and challenging learning experiences that inspire students to participate (Sungkono et al., 2024) actively Click or tap here to enter text. By presenting interactive and varied learning experiences, students' attention can be improved, and their enthusiasm for learning can be fostered.

Paying attention to the various learning needs of students is essential and should not be overlooked. By paying attention to the needs of each student, enthusiasm for the learning process can be increased. (Syahputri et al., 2023). Differentiated learning is the answer to these needs through adjustments to the material, process, and product according to their individual characteristics. (Istiqomah et al., 2024). Through this approach, students' active participation in the learning process will increase, positively impacting their understanding of the material. Additionally, meeting students' needs can foster a harmonious atmosphere between teachers and students, making the learning interaction more positive.

Based on the above explanation, this study aims to investigate the effect of differentiated learning styles on elementary school students' mathematics learning outcomes. The primary focus of this study is the extent to which differentiated learning styles can influence student learning outcomes. This article is expected to contribute to learning. Based on a review of the literature, previous studies such as those conducted by Sabarikun & Purnomo (2023) Which discussed how differentiated learning can improve students' knowledge, and studies conducted by Amalia & Siswanto (2024). This also discusses how differentiated learning can improve student learning outcomes. This study presents a novelty, namely differentiated learning focused on students' learning styles and their learning outcomes.

Overall, the implementation of differentiated learning tailored to students' learning styles can contribute to improving student learning

outcomes. Research shows that by considering the diversity of students and meeting their needs, learning becomes more enjoyable and effective (Alfath et al., 2023; Hasibuan et al., 2024). The research question is how differentiated learning styles affect student learning outcomes, with the aim of determining this effect. The results of the study are expected to increase learning outcomes and provide an alternative solution for improving the quality of learning.

B. Metode

This study uses a quantitative research method with a quasi-experimental design. According to Sugiyono (2011), a quasi-experiment is a study to determine whether a treatment will affect the results of a study. This effect is assessed by applying a specific experiment to one group, called the experimental class, and not applying the experiment to another group, called the control class.

This study uses differentiated learning styles as variable X and student learning motivation as variable Y. This study uses a nonequivalent control group design, which is similar to the pretest-posttest control group design described in the following figure (control and experimental groups):

	pretest measure,	treatment	posttest measure
Experimental Group (KE)	O_1	X_1	O_2
	pretest measure,	treatment,	posttest measure
Kontrol group (KK)	O_3	-	O_4

Figure 1. Research Design (Source: Sugiyono, 2011).

The population and sample in this study were fourth-grade elementary school students in Sendang Subdistrict, Tulungagung Regency. The study used two learning groups, namely classes 4A and 4 B. Class 4A was referred to as the experimental class, and Class 4B was referred to as the control class. This study used nonprobability sampling, and the sampling technique used was purposive sampling.

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This study used a data collection technique in the form of test questions developed by the researcher. The type of instrument validity used was construct validity, which shows the extent to which the instrument can reveal particular abilities or theoretical constructs being measured. The determination of validity in this study uses exploratory factor analysis (EFA), which is used when the measurement model of the instrument is still being sought, developed independently, or explored (Retnawati, 2016). The test questions were designed and adapted to the cognitive levels of C1-C6 in the measurement of length in fourth-grade mathematics. The test consisted of 20 multiple-choice questions with 1 point for a correct answer and 0 points for an incorrect answer. The test was administered twice, before the treatment (pretest) and after the treatment (posttest).

The data analysis used in this study was performed using Jamovi ver 2.3.28, which includes prerequisite tests and hypothesis tests. Prerequisite tests include normality tests and homogeneity tests. The normality test was performed using the Shapiro-Wilk normality test with the assumption that if $p > 0.05$, the data is normally distributed, and conversely, if $p < 0.05$, the data is not normally distributed. The criteria for the null hypothesis and its alternative are as follows:

H_0: Data has a normal distribution.
H_1: Data has not a normal distribution.

A homogeneity test was conducted to determine whether the samples used in the study originated from the same variance or not. The homogeneity test used the Homogeneity of Variances Test (Levene's). The homogeneity test is determined by the significance level (sig.). If the value (sig.) > 0.05, the data is considered homogeneous, and if the value (sig.) < 0.05, the data is considered non-homogeneous. The criteria for the null hypothesis and its alternative are as follows:

H_0: Homogeneous group variance.
H_1: Group variance is not homogeneous.

Hypothesis testing was conducted after the prerequisite tests were fulfilled. The hypothesis tests conducted were t-tests and tests of the effect of independent variables on dependent variables. The t-test (Independent Sample T-Test) was conducted to determine the difference between the control and experimental groups. The t-test (Independent Sample T-Test) in this study uses the Jamovi 2.3.28 program. The criteria for accepting or rejecting H_0 at a significance level of 5% using significance are as follows: if significance > 0.05, then H_0 is accepted; conversely, if significance < 0.05, then H_0 is rejected. The research hypothesis is as follows:

H_0: Differentiated learning styles do not affect student learning outcomes.
H_1: Differentiated learning styles have an effect on student learning outcomes.

C. Result and Discussion

Data analysis in this study was assisted by the Jamovi application version 2.3.28. Data testing and analysis began with instrument testing, prerequisite testing, and hypothesis testing. The results of the analysis are presented below.

1. Results

The validity test results show valid and reliable instrument data. This test uses Jamovi software version 2.3.28 with assumption checks by looking at the results of Bartlett's Test of Sphericity to assess validity and using Cronbach's Alpha test to assess reliability. The following are the criteria for assessing Cronbach's Alpha:

Table 1. Criteria of Cronbach's Alpha

Cronbach's Alpha	***Interpretation* of Cronbach's Alpha Coefficient**
0.00 – 0.49	Low
0.50 – 0.69	Moderate
0.70 – 0.89	High
0.*90* – 1.00	Very High

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Source: Taherdoost (2016)

The instrument criteria are considered valid if the p-value is less than 0.05 in Bartlett's Test of Sphericity. The instrument criteria are considered reliable if the p-value is greater than 0.5 in Cronbach's Alpha.

The results of the questionnaire validity test are as follows:

Table 2. Validity Test Result

Bartlett's Test of Sphericity		
χ^2	df	p
1226	190	< .001

The results of Bartlett's Test of Sphericity for both instruments showed a p-value of less than 0.001. According to Retnawati (2016), a p-value below 0.01 indicates that the sample size is sufficient for factor analysis. This finding is further supported by KMO MSA, as explained below:

Table 3. KMO MSA

KMO Measure of Sampling Adequacy	
	MSA
Overall	0.886
S1	0.916
S2	0.937
S3	0.888
S4	0.853
S5	0.850
S6	0.872
S7	0.840
S8	0.847
S9	0.894
S10	0.920
S11	0.930
S12	0.892
S13	0.888
S14	0.826
S15	0.865
S16	0.896
S17	0.920
S18	0.834

S19	0.922
S20	0.884

The construct validity assessment for the test instrument yielded a KMO MSA value of 0.886. All items in this instrument had values above 0.5, which, according to Retnawati (2016), indicates that the data is adequate for factor analysis. In addition to the KMO analysis, the number of factors in the instrument was analysed using a scree plot and eigenvalue, which consistently showed a sharp peak followed by a slope. This indicates that the items in the instrument contain only one primary factor, thereby confirming that the instrument used has valid construct validity for measuring learning outcomes.

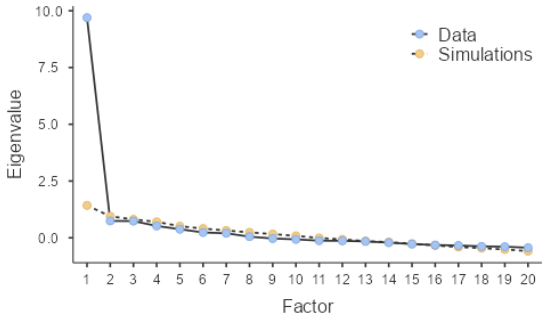

Figure 2. Scree Plot

Based on the scree plot results, there is a sharp point indicating that the instrument has only one significant dominant factor. This shows that all items in the instrument consistently measure one main construct, namely learning outcomes. This result is reinforced by the Eigen Value, which shows that only one factor with the highest value is significantly greater than the other factors. Therefore, it is concluded that the instrument used has structural validity that meets the requirements for use in this study.

Table 4. Eigen Values

Initial Eigenvalues	
Factor	**Eigenvalue**
1	9.6942
2	0.7438

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Initial Eigenvalues	
Factor	**Eigenvalue**
3	0.7358
4	0.5226
5	0.3779
6	0.2350
7	0.2000
8	0.0503
9	-0.0306
10	-0.0684
11	-0.1258
12	-0.1334
13	-0.1581
14	-0.2131
15	-0.2753
16	-0.3172
17	-0.3386
18	-0.3764
19	-0.3912
20	-0.4371

Based on the results of Exploratory Factor Analysis (EFA), it can be concluded that the instrument consisting of questionnaires has met the construct validity criteria, making it suitable for measuring learning outcomes. The validity of the instrument is supported by empirical evidence showing that the items in the instrument are able to represent the theoretical aspects being measured consistently and accurately.

The reliability test conducted using the Jamovi application version 2.3.28 produced the following results:

Table 5. Reliability Test Result

Scale Reliability Statistics		
	Mean	**Cronbach's α**
Scale	0.842	0.945

The Cronbach's Alpha coefficient value of the test instrument is 0.945. Based on Table 1, the determination of the Cronbach's Alpha coefficient classification level shows that the value of 0.945 is in the very high reliability range. The analysis results show that the test instrument has a very high level

of reliability (Retnawati, 2016). This result is reinforced by the item-rest correlation table as follows:

Table 6. Item-rest Correlation

Item Reliability Statistics	
	Item-rest correlation
S1	0.698
S2	0.872
S3	0.602
S4	0.672
S5	0.737
S6	0.739
S7	0.609
S8	0.542
S9	0.698
S10	0.724
S11	0.602
S12	0.692
S13	0.692
S14	0.658
S15	0.549
S16	0.720
S17	0.679
S18	0.623
S19	0.677
S20	0.649

Item-rest correlation is used to determine the level of relationship between the score of each item in the instrument and the overall score. A positive correlation indicates that the item is relevant and represents the construct being measured, while a negative correlation indicates that the item needs to be revised or deleted (Wibowo & Kurniawan, 2020). Based on the results of the analysis in Table 6, all items have positive correlation values, which means that the learning motivation questionnaire used in this study is valid and reliable.

The initial stage of hypothesis testing is the implementation of prerequisite tests, which include normality tests and homogeneity tests. Based on the normality test, it was found that the data shown in the table below.

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Table 7. Normality Test Result

Normality Test (Shapiro-Wilk)		
	W	**p**
PRETES	0.945	0.111
POSTES	0.949	0.150

Note. A low p-value suggests a violation of the assumption of normality

Referring to the results of the Shapiro-Wilk test for normality, the pre-test result value was 0.111 and the post-test result was 0.150. Since these values are above the significance threshold of 0.05, the data conforms to a normal distribution. Therefore, the null hypothesis (H_0), which states that the data follows a normal distribution, can be accepted. Additionally, the assumption of normality is supported by the Q-Q plot (Quantile-Quantile Plot). When the data points align closely with the reference diagonal line on the plot, this indicates that the data follows a normal distribution. The visual representation of the Q-Q plot is shown in the graph below.

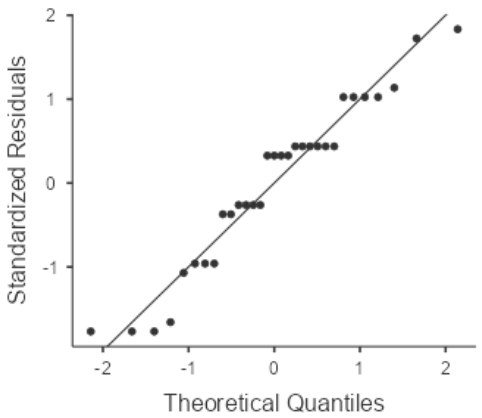

Figure 3. Q-Q Plot Pretes

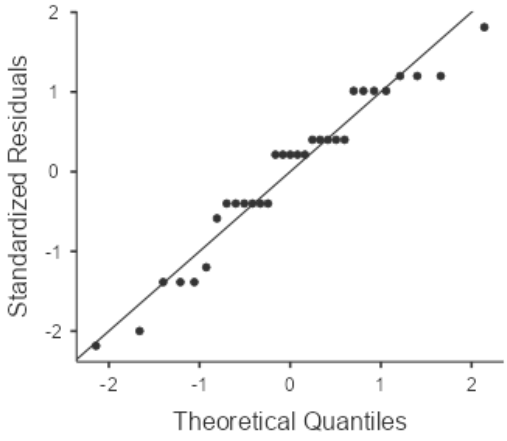

Figure 4. Q-Q Plot Posttest

The Q-Q Plot graph shows that the distribution of data points is parallel to the diagonal line. This indicates that the research data is typically distributed.

The results of the homogeneity test are shown as follows:

Table 8. Homogenity Test Result

Homogeneity of Variances Test (Levene's)				
	F	**df**	**df2**	**p**
PRETES	1.64	1	29	0.210
POSTES	1.21	1	29	0.281
Note. A low p-value suggests a violation of the assumption of equal variances				

Based on the results of the homogeneity test using Levene's test, a significance value (p-value) of 0.210 was obtained for the pre-test data and 0.281 for the post-test data. Both values are greater than the significance level of 0.05, which means that H_0 is accepted and there is no significant difference in variance between the groups tested. Thus, it can be concluded that the pre-test and post-test data have homogeneous variances. These results indicate that the assumption of homogeneity is satisfied.

Hypothesis testing was conducted after the prerequisite tests were fulfilled. The hypothesis tests conducted were t-tests and tests of the effect of independent variables on dependent variables. The t-test (Independent

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Sample T-Test) was conducted to determine the difference between the control class and the experimental class. The t-test (Independent Sample T-Test) in this study used the Jamovi 2.3.28 program with the following results:

Table 9. Hypothesis Test Result

Independent Samples T-Test				
		Statistic	**df**	**p**
PRETES	Student's t	-3.52	29.0	0.001
POSTES	Student's t	-10.43	29.0	< .001
Note. H_a $\mu_1 \neq \mu_2$				

Based on the results of the analysis using the independent sample t-test, the t-statistic value for the pre-test data was -3.52 with a degree of freedom (df) of 29 and a significance value (p) of 0.001. Meanwhile, for the post-test data, the t-statistic value is -10.43 with df 29 and a significance value also less than 0.001. Since the p-value is less than 0.001 in both tests, the results indicate a statistically significant difference between the two groups tested, both before (pre-test) and after (post-test) the treatment. Therefore, the null hypothesis (H_0) stating that there is no difference in means is rejected, and the alternative hypothesis (H_a: $\mu_1 \neq \mu_2$) is accepted. Thus, it can be concluded that there is an effect of differentiated learning styles on student learning outcomes.

2. Discussion

This study was conducted on two classes, namely an experimental class where differentiated learning styles were applied and a control class where conventional learning was applied. The two classes were tested to determine how this affected student learning outcomes between the treated and untreated classes. Student learning outcome data were collected using a research instrument in the form of test questions, which had previously been tested using Jamovi version 2.3.28. The results of the instrument validation showed that Bartlett's Test of Sphericity yielded a p-value < 0.001 and Cronbach's Alpha of 0.950, indicating that the instrument was valid and reliable. The student learning outcomes data from the control and experimental

classes were then analysed, and a prerequisite test was conducted before proceeding with the hypothesis test using Jamovi version 2.3.28.

The prerequisite test was conducted using a normality test with Shapiro-Wilk test results for the pre-test score of 0.206 and post-test score of 0.272, indicating that the value was >0.05, thus the data was declared to be normally distributed. Furthermore, the homogeneity test yielded Levene's test results with p-values of 0.607 (pre-test) and 0.493 (post-test), where these values are >0.05, so the data is considered homogeneous. With the prerequisite tests fulfilled, the hypothesis test can be conducted, yielding a p-value of <0.001 in the t-test (Independent Sample T-Test), indicating a significant effect. Based on these results, it can be concluded that differentiated learning based on learning styles has an effect on student learning outcomes.

Differentiated learning styles is an innovative approach to teaching that focuses on adapting learning methods to the characteristics of each student, particularly in fourth grade mathematics classes. (Choirina et al., 2024) shows that when teachers adapt their teaching methods to align with students' learning styles, there is an increase in knowledge and understanding of mathematics material. Amalia (2024) adds that this approach is an efficient breakthrough in improving learning outcomes, while Latifah (2023) emphasizes the importance of creating an inclusive and responsive learning environment that accommodates diverse learning styles. In the context of mathematics learning, students use visual media such as images and videos, engage actively in activities like measuring objects around them (kinesthetic), and listen to explanations and audio (auditory). Considering the variety of learning styles is believed to increase their participation levels, which directly contributes to student learning outcomes.

Differentiated instruction is an approach that provides learning experiences tailored to students' needs, interests, and learning styles. In the context of elementary schools, the implementation of differentiated instruction based on learning styles (visual, auditory, and kinesthetic) has been proven to improve learning outcomes significantly. Research by Taş & Minaz (2024),

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shows that socially-based learning activities integrated through layered teaching and learning stations successfully improved students' academic performance significantly. In this quasi-experimental study, the experimental group that received differentiated instruction experienced a much greater increase in scores compared to the control group taught traditionally.

The application of learning styles in differentiated instruction has also been shown to be effective in various other primary education contexts. For example, a study by Salazar & Gumanoy (2025) In the Philippines, studies showed that differentiated mathematics instruction increased student motivation and engagement, which ultimately led to improved learning outcomes. Teachers in this study used strategies such as flexible grouping and learning centres to accommodate students' learning styles, and the results showed a significant improvement in students' academic performance. In Indonesia itself, a study by Sati et al., (2024) shows that elementary school teachers who understand and accommodate students' learning styles can create more effective and enjoyable learning experiences. Teachers who combine visual, auditory, and kinesthetic approaches are able to accommodate student diversity and maximise their learning potential. Learning becomes more contextual, interactive, and student-centred, thereby minimising boredom and increasing active student participation in the classroom.

The diversity of student characteristics, such as preferences for instructional videos or practice questions, indicates that interacting with the real world through the material being studied is an effective way to increase motivation (Faiz et al., 2022; Handiyani & Muhtar, 2022). In addition, Demir (2021) explains that differentiated learning provides opportunities for students to participate in the entire learning process actively. Activities such as brainstorming, discussions, internet-based information searches, drama, independent learning, and flexible group work are examples of strategies that can be applied in this model. This approach is considered adequate because it provides various methods relevant to each individual's learning style and needs, something not found in conventional learning.

Differentiated instruction is a teaching strategy designed to tailor the learning process to the needs, interests, and learning styles of individual students. This strategy has been proven to have a significant impact on improving student learning outcomes and motivation at the elementary school level, especially among fourth-grade students. (Istiqomah et al., 2024). Adjusting content, process, and outcomes allows teachers to design learning that is appropriate for students' readiness, creating an environment that supports understanding of the material and encourages creativity and independence in problem solving. By providing opportunities for active participation, asking questions, and expressing opinions, differentiated learning can facilitate diversity in individual characteristics and strengthen the role of students as subjects in learning. This view is reinforced by Asriadi et al., (2023), who state that differentiated learning emphasises the importance of recognising individual differences, whether in terms of readiness, interests, or learning profiles. This creates learning experiences that align with children's interests, making learning more challenging and encouraging active student participation. Teachers can also provide more targeted and constructive feedback. By considering the unique characteristics and needs of each learner, differentiated learning has been proven to enhance motivation, engagement, understanding, and learning skills, ultimately impacting students' learning outcomes.

D. Conclusion

The results of this study can be concluded that there is an effect of differentiated learning styles on student learning motivation. Supported by the results of the hypothesis test, a significant value of $p<0.001$ was obtained, indicating a significant effect. Based on these results, it is hoped that differentiated learning styles can be applied in classroom instruction, thereby addressing the diverse needs of students and fostering high levels of learning motivation to achieve high academic outcomes.

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