

The Implementation of Process Differentiated Instruction Based on VARK Learning Styles for Junior High School Students in Solving Statistics Problems

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ABSTRACT

This research was prompted by a discrepancy between the Merdeka Curriculum's mandate for diverse learning and the continued use of conventional teaching at SMPN 1 Panti. The study aimed to implement and describe the effects of process-differentiated instruction based on VARK learning styles on students' statistical problem-solving abilities. A quasi-experimental, nonequivalent control group design was employed, involving two eighth-grade classes: an experimental group ($n = 29$) and a control group ($n = 29$). The experimental group received process differentiation tailored to VARK styles, while the control group received conventional instruction. Data were collected via pretests and posttests and analyzed using non-parametric statistics. The findings showed no statistically significant difference in problem-solving outcomes between the two groups (Mann-Whitney U, $p = 0,151$). However, the Wilcoxon Signed-Rank test revealed a significant improvement in the experimental group's scores from pretest to posttest ($p = 0,000$). Moreover, student interviews indicated that the differentiated approach significantly increased their motivation and engagement. It was concluded that while the short-term intervention did not yield statistically superior test scores, it profoundly enhanced the learning process and student experience.

Keywords: *Differentiated Instruction, VARK Learning Styles, Statistics.*

Implementasi Pembelajaran Berdiferensiasi Proses Berdasarkan Model Gaya Belajar VARK Pada Siswa SMP Dalam Menyelesaikan Persoalan Statistika

ABSTRAK

Penelitian ini dilatarbelakangi oleh adanya kesenjangan antara amanat Kurikulum Merdeka untuk mengakomodasi keberagaman belajar dengan praktik pembelajaran konvensional di SMPN 1 Panti. Tujuan penelitian ini adalah untuk mengimplementasikan dan mendeskripsikan dampak dari pembelajaran berdiferensiasi proses berdasarkan gaya

belajar VARK terhadap kemampuan pemecahan masalah statistika siswa. Metode yang digunakan adalah kuasi-eksperimen dengan desain *Nonequivalent Control Group*, melibatkan dua kelas VIII: kelas eksperimen ($n = 29$) dan kelas kontrol ($n = 29$). Kelas eksperimen menerima pembelajaran berdiferensiasi proses yang disesuaikan dengan gaya belajar VARK, sedangkan kelas kontrol menerima pembelajaran konvensional. Data dikumpulkan melalui *pretest-posttest* dan dianalisis menggunakan statistik non-parametrik. Hasil penelitian menunjukkan tidak terdapat perbedaan yang signifikan secara statistik pada kemampuan pemecahan masalah antara kedua kelompok (Mann-Whitney U, $p = 0,151$). Namun, uji Wilcoxon Signed-Rank menunjukkan adanya peningkatan yang signifikan pada skor kelas eksperimen dari *pretest* ke *posttest* ($p = 0,000$). Selain itu, wawancara siswa mengindikasikan bahwa pendekatan diferensiasi secara signifikan meningkatkan motivasi dan keterlibatan mereka. Disimpulkan bahwa meskipun intervensi jangka pendek tidak menghasilkan nilai tes yang unggul secara statistik, pendekatan ini secara mendalam meningkatkan proses dan pengalaman belajar siswa.

Kata Kunci: Pembelajaran Berdiferensiasi, Gaya Belajar VARK, Statistika.

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1. Introduction

The Indonesian government's commitment to improving national education is embodied in the Merdeka Curriculum, a policy designed to provide educators with the autonomy to create quality learning environments tailored to the diverse needs and potentials of students (Arantini et al., 2024). In line with this, Cholilah et al. (2023) state that the Merdeka Curriculum is founded on the principles of students' natural dispositions and the context of the era, recognizing the diversity of students' interests and talents as the basis for learning implementation. Furthermore, the implementation of the Merdeka Curriculum also influences aspects of learning conducted by teachers, including the need to design learning strategies that more concretely adjust to students' interests, learning readiness, and learning profiles (Najib et al., 2024). This paradigm requires a shift towards teaching strategies that are more adaptive and student-centered.

Differentiated Instruction is one pedagogical approach that directly aligns with the philosophy of the Merdeka Curriculum. Differentiated Instruction is a teaching framework developed to effectively and proactively respond to student diversity in the classroom, and every student is empowered to achieve their full potential (Faiz et al., 2022; Amalia et al., 2023; Tomlinson, 2022). Its goal is to maximize learning by adapting four key classroom elements: content, process, product, and the learning environment (Tomlinson, 2017; Tomlinson, 2023). This approach encourages teachers to be flexible and adaptive, fostering a learning environment that accommodates a range of interests, skills, and learning styles (Afriana et al., 2024; Khan et al., 2024; Alhafiz, 2022). By doing so, differentiated instruction aims to enhance student motivation and learning outcomes while fostering a harmonious relationship between teachers and students, ultimately helping students become independent learners (Marlina, 2021). This strategy encourages equality and inclusion in the classroom, ensuring equal chances for all students to achieve their learning goals, and offers a balanced and equitable educational

experience. This approach is increasingly recognized for its potential to foster an inclusive and effective learning environment ([Ab Hajis, 2024](#)).

Numerous studies have demonstrated the positive impact of differentiated instruction. [Siburian et al. \(2022\)](#) showed that students receiving differentiated instruction had better mathematical problem-solving skills than those in conventional classrooms. Similarly, [Muhlisah et al. \(2023\)](#) found that differentiated instruction positively influenced students' critical and creative mathematical thinking skills, while [Bulu \(2023\)](#) confirmed its positive effect on learning outcomes. Other studies by [Winahyu et al. \(2024\)](#) and [Arantini et al. \(2024\)](#) have also linked differentiated instruction to increased student motivation and active participation in learning activities. The study of [Pasira \(2022\)](#) and [Magableh \(2020\)](#) proves that effective differentiation enhances the level of student's interest, motivation and achievement, and it was operational in improving students.

Beyond these four adaptable elements, Differentiated Instruction (DI) is guided by several core characteristics that distinguish it from traditional teaching: it is proactive, focuses on quality rather than quantity, is driven by assessment, employs multiple approaches to content, process, product, and the learning environment, is student-centered, blends individual and group learning, and is dynamic and continuously evolving ([Purba et al., 2021](#)). These characteristics can be described as follows. First, proactive planning involves anticipating students' diverse learning needs from the outset by designing lessons that accommodate different learners, rather than modifying instruction only after assessments reveal learning difficulties. Second, a focus on quality over quantity emphasizes tailoring homework and assignments to individual learning needs to promote skill development rather than simply increasing the amount of work. Third, assessment-driven instruction involves continuously evaluating students through various methods to understand their learning progress and adjust instruction accordingly. Fourth, multiple approaches to teaching and learning allow teachers to differentiate content, process, product, and the learning environment according to students' readiness, interests, and learning profiles. Fifth, student-centered instruction involves adapting learning tasks and activities to students' levels of understanding and individual needs. Sixth, a blend of individual and group learning provides opportunities for students to learn collaboratively as a class or in groups, as well as independently. Finally, a dynamic and evolving process involves teachers working in partnership with students to establish class-wide and individual learning goals, monitor learning progress, and make ongoing adjustments to instruction.

This study specifically focuses on process differentiation, which, according to [Naibaho \(2023\)](#), is a strategy where the teacher observes and analyzes the learning undertaken by students, both independently and in groups. The basis for this differentiation is the students' learning styles. Fleming in [Widharyanto \(2017\)](#) states that a learning style is an individual characteristic that each person has in collecting, organizing, and thinking about information. This differentiation was based on the VARK learning styles model (Visual, Auditory, Read/Write, and Kinesthetic), a framework used to identify students' preferences for gathering and processing information. Drawing on [Widharyanto \(2017\)](#), [Azkiya et al. \(2024\)](#), and [Ulya et al. \(2024\)](#), the characteristics associated with each VARK learning style are described as follows. The visual learning style is characterized by a preference for graphic representations, such as pictures, diagrams, and videos. Individuals with this learning style tend to speak relatively quickly, are not easily distracted by surrounding noise, and think in images, which helps them understand concepts through visual relationships. The auditory learning style is characterized by a preference for listening to others and discussing topics and ideas with people around them. Individuals with this learning style also tend to talk to themselves or think aloud while performing tasks. The read/write learning style is characterized by a preference for taking notes on information received and obtaining information from written sources, such as articles

and books. Finally, the kinesthetics learning style is characterized by a preference for hands-on learning activities, such as experiments and simulations, and individuals with this learning style tend to speak slowly.

Fleming in [Mahmood \(2023\)](#) also argues that every learner has a different learning style, so they may have a unilateral or multilateral learning style because they use two or more VARK styles. However, mastery of many representations is a fundamental requirement of mathematics. To succeed, pupils must be able to manage equations (Read/Write), interpret graphs (Visual), and solve problems through object manipulation (Kinesthetic). Developing a thorough knowledge may suffer if education is restricted to a single style. But the results of Mahmood's research ([2023](#)) show that the reading/writing style and visual style based on the VARK model are more common among students in the Department of Mathematics, University of Mosul. Thus, this study provides an alternative in Mathematics learning on the topic of Statistics, particularly in the data collection process tailored to students' preferred learning styles so that students will be more involved, motivated, and have an impact on higher achievement.

Accommodating these diverse learning styles is crucial, as students tend to be more actively engaged and motivated when instruction aligns with their preferences ([Olusegun & Blessing, 2024](#)). However, it must be understood that in practice, students may have a mix of learning styles or no single dominant style, making a singular classification approach ineffective ([Altamimi et al., 2022](#)). Critics note that learning style inventories can risk oversimplifying complex cognitive traits, and the assumption that these styles are fixed can hinder the development of flexible learning strategies in students. This fact further strengthens the urgency of implementing differentiated instructions to equitably serve all students. Therefore, to address this diversity, a diagnostic assessment is needed to identify students' competencies, strengths, and weaknesses so that learning can be planned according to their abilities and needs ([Junaidah et al., 2023](#)).

The novelty of this research lies in its specific focus and context. While previous research has confirmed the general benefits of differentiated instruction, this study addresses a specific gap observed at SMPN 1 Panti: the lack of practical implementation of the Merdeka Curriculum's principles. This research provides a concrete model of process differentiation tailored specifically to VARK learning styles within the subject of statistics. The combination of these variables a specific differentiated instruction strategy, a learning styles framework, a particular mathematics topic, and a classroom context struggling with implementation constitutes its unique contribution. The study moves beyond general effects to explore a practical application designed to bridge the gap between curriculum ideals and classroom reality.

The subject of statistics was chosen as the context for this research due to its strong connection to real-world, contextual problems. According to Yusuf in [Wulansari et al. \(2019\)](#), statistics is a tool that can be used to solve contextual problems in daily life as well as in science. This makes it an ideal platform for process differentiation, as students can engage with data in multiple ways: visual learners can interpret charts and diagrams, auditory learners can discuss findings, read/write learners can analyze data tables and reports, and kinesthetic learners can participate in hands-on data collection activities.

Therefore, the primary objective of this research is to implement and describe the effects of process differentiated instruction based on learning styles on junior high school students' ability to solve statistics problems. The study aims to provide practical insights into how this tailored approach can be applied in a real-world classroom setting, analyzing its impact on the learning process and student outcomes compared to conventional methods.

2. Research Method

2.1 Research Design

The experimental research method is a quantitative research method aimed at determining the impact of a specific treatment on other variables under controlled conditions ([Sugiyono, 2020](#)). In accordance with this, the study employed a quantitative approach with a Quasi-Experimental Design, specifically utilizing the nonequivalent control group design. This design was selected to assess the effect of a specific treatment (differentiated instruction) on an experimental group by comparing its outcomes with a control group that did not receive the treatment. The treatment on experimental group is Differentiation of processes tailored to VARK learning styles differ in the statistical data collection or observation process. The visual learning group was asked to observe students' shoe sizes at school, the auditory learning group was asked to inquire about students' weights at school, the reading/writing learning group was asked to collect students' math test scores, and the kinesthetic group was asked to measure students' heights in the school area. This method is appropriate as random assignment of students to classes was not feasible in the school setting.

The population for this study consisted of all eighth-grade students at SMPN 1 Panti, Jember Regency, during the 2024/2025 academic year. The sample was selected using a Purposive Sampling technique, which involves choosing participants based on specific criteria relevant to the research objectives. The primary criteria were that students had not yet received formal instruction on the topic of statistics and were recommended by the mathematics teacher. Based on these criteria, Class VIII G was assigned as the experimental group, and Class VIII F was assigned as the control group. To ensure that both groups had comparable initial abilities, a homogeneity test was conducted on the midterm assessment scores of the population, which confirmed that the population was homogeneous ($\text{Sig.} = 0.655$).

Table 1. Homogeneity Test Results for the Research Population's Midterm Scores

Test of Homogeneity of Variances		Levene Statistic	df1	df2	Sig.
Midterm Assesment	Based on Mean	.694	6	196	.655
	Based on Median	.502	6	196	.806
	Based on Median and with adjusted df	.502	6	166.037	.806
	Based on trimmed mean	.647	6	196	.693

As a further analysis to ensure that the selected research sample had equivalent initial abilities, a descriptive analysis and a homogeneity test were conducted on the midterm assessment mathematics scores of the sample. The results of the descriptive analysis can be seen in Table 2.

Table 2. Descriptive Analysis of Mathematics Midterm Scores for the Research Sample

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Experimental Class	29	72	25	97	73.21	16.584	275.027
Control Class	29	66	34	100	77.62	18.302	334.958
Valid N (listwise)	29						

Based on Table 2, it can be concluded that the initial mathematics ability between the experimental and control classes is relatively equivalent and comparable. Although the mean score of the control class (77,62) is slightly higher than that of the experimental class (73,21), this difference is not substantial. Furthermore, the distribution of student abilities in both classes shows similarity. This is evident from the standard deviation values, which are not far apart 16,584 for the experimental class and 18,302 for the control class. Subsequently, a

homogeneity test was performed to reinforce the descriptive findings on the sample's mathematics PTS scores. The results of this test are presented in Table 3.

Table 3. Results of the Homogeneity Test on the Research Sample's Mathematics Midterm Scores

Test of Homogeneity of Variances		Levene Statistic	df1	df2	Sig.
Nilai PTS	Based on Mean	.047	1	56	.829
Sampel	Based on Median	.027	1	56	.871
Penelitian	Based on Median and with adjusted df	.027	1	55.258	.871
	Based on trimmed mean	.008	1	56	.930

Based on Table 3, the significance obtained is 0,892. According to the decision-making rule for the homogeneity test, because the significance value is greater than 0,05 (sig. > 0,05), it can be concluded that the selected research sample has the same initial ability.

Several instruments were developed and validated to collect data in this study. The primary teaching tools were the Teaching Guides, which included specific modules for both the differentiated learning class and the conventional learning class, designed for a three meetings implementation. A key instrument for the experimental group was the Student Worksheets, with four distinct versions created to cater to each of the VARK learning styles. To classify students into these learning style groups, a non-cognitive Diagnostic Assessment in the form of a questionnaire was utilized. To measure student outcomes, two main instruments were used. The first was a Test, consisting of a pretest and a posttest with three essay questions each, designed to assess students' ability to solve statistics problems. The second was a semi-structured Interview Guide, containing six questions used to gain deeper qualitative insights into the students' thinking processes and learning experiences. The pretest and posttest questions each consisted of 3 questions. The average validity was 3.79 (valid) and reliability with a Cronbach's alpha score of 0.76 (reliable).

The research procedure was conducted systematically, beginning with the preparation and validation of all instruments by experts. Once validated, the implementation phase in the field commenced with the administration of a pretest to both the experimental and control groups to measure their baseline abilities. Following the pretest, the treatment was carried out over three meetings. The control group received conventional instruction, primarily using the lecture method. In contrast, the experimental group received differentiated instruction. After being grouped based on the VARK learning style assessment, each group worked on a Student Worksheet with specifically designed data collection activities. The Visual group was tasked with observing and presenting data on student shoe sizes. The Auditory group was asked to inquire about and record data on student weights through interviews. The Read/Write group was assigned to collect data on student math exam scores from written sources. The Kinesthetic group directly measured and recorded data on student heights within the school environment.

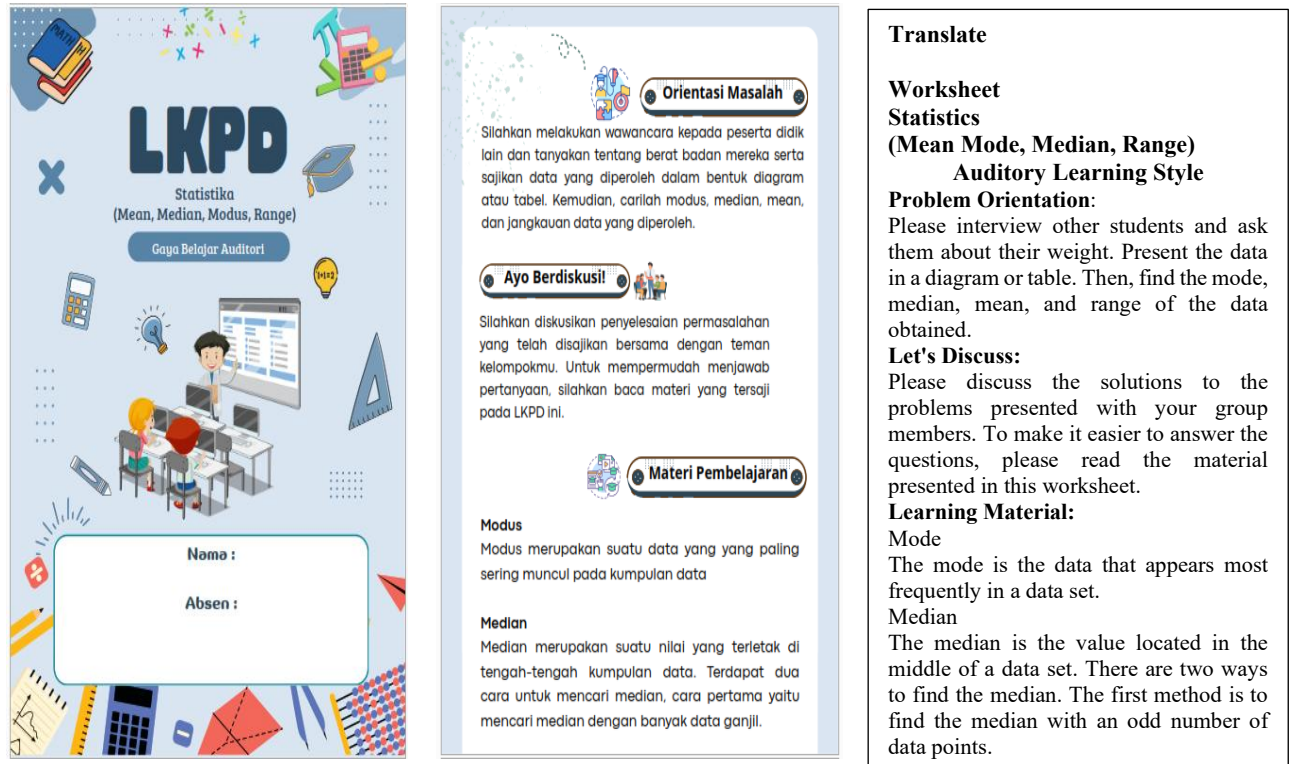


Figure 1. Example of worksheet for Auditory learning styles

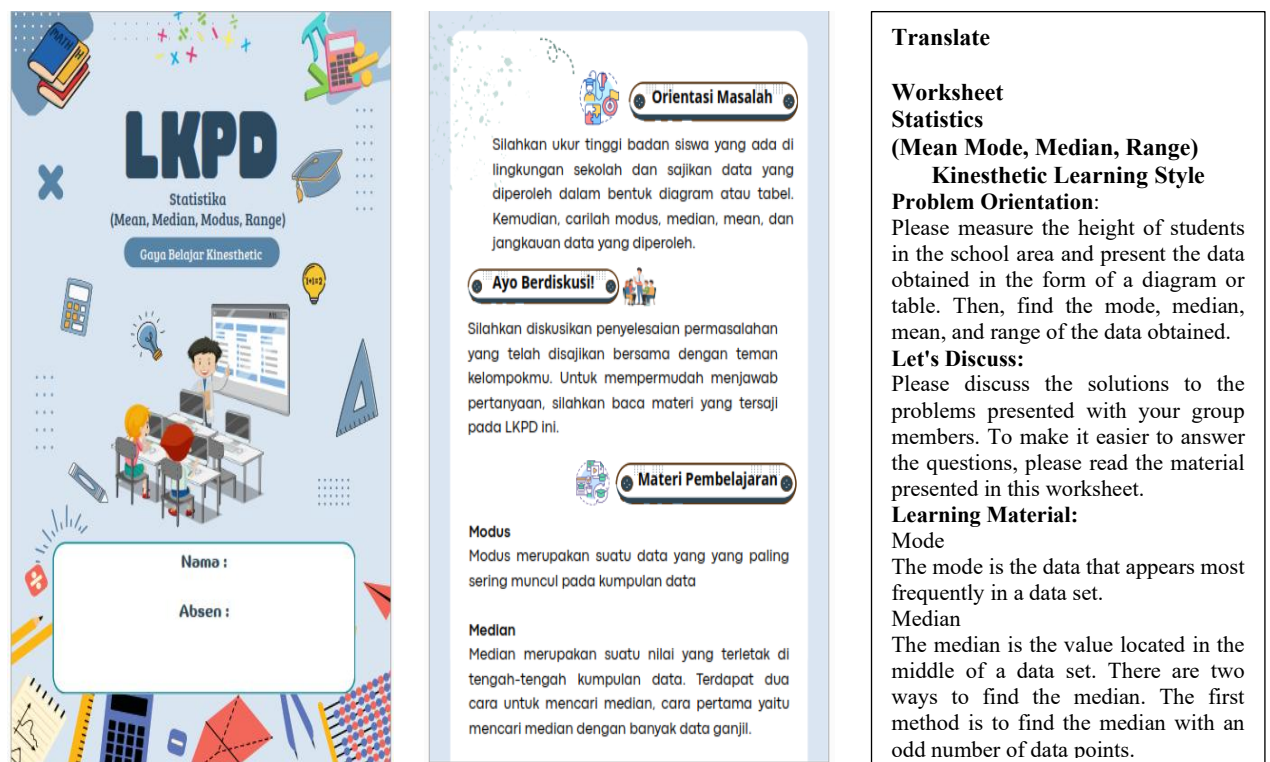


Figure 2. Kinesthetic learning styles worksheet

The implementation phase concluded with a post test administered to both groups. Additional qualitative data was also collected through interviews with representative students from the experimental group after the study was completed. Subsequently, the research flow diagram, illustrating each stage in its entirety, is presented in Figure 3.

The quantitative data from the pretest and post test scores were analyzed using statistical tests. The prerequisite analyses conducted were the Shapiro-Wilk test for normality and Levene's Test for homogeneity. The results indicated that the data were not normally distributed (Sig. < 0,05) but were homogeneous (Sig. > 0,05). Therefore, the data analysis proceeded using non-parametric statistics. The Wilcoxon Signed-Rank Test was used to compare the pretest and posttest scores within each group, while the Mann-Whitney U Test was used to compare the posttest scores between the experimental and control groups to answer the research hypothesis.

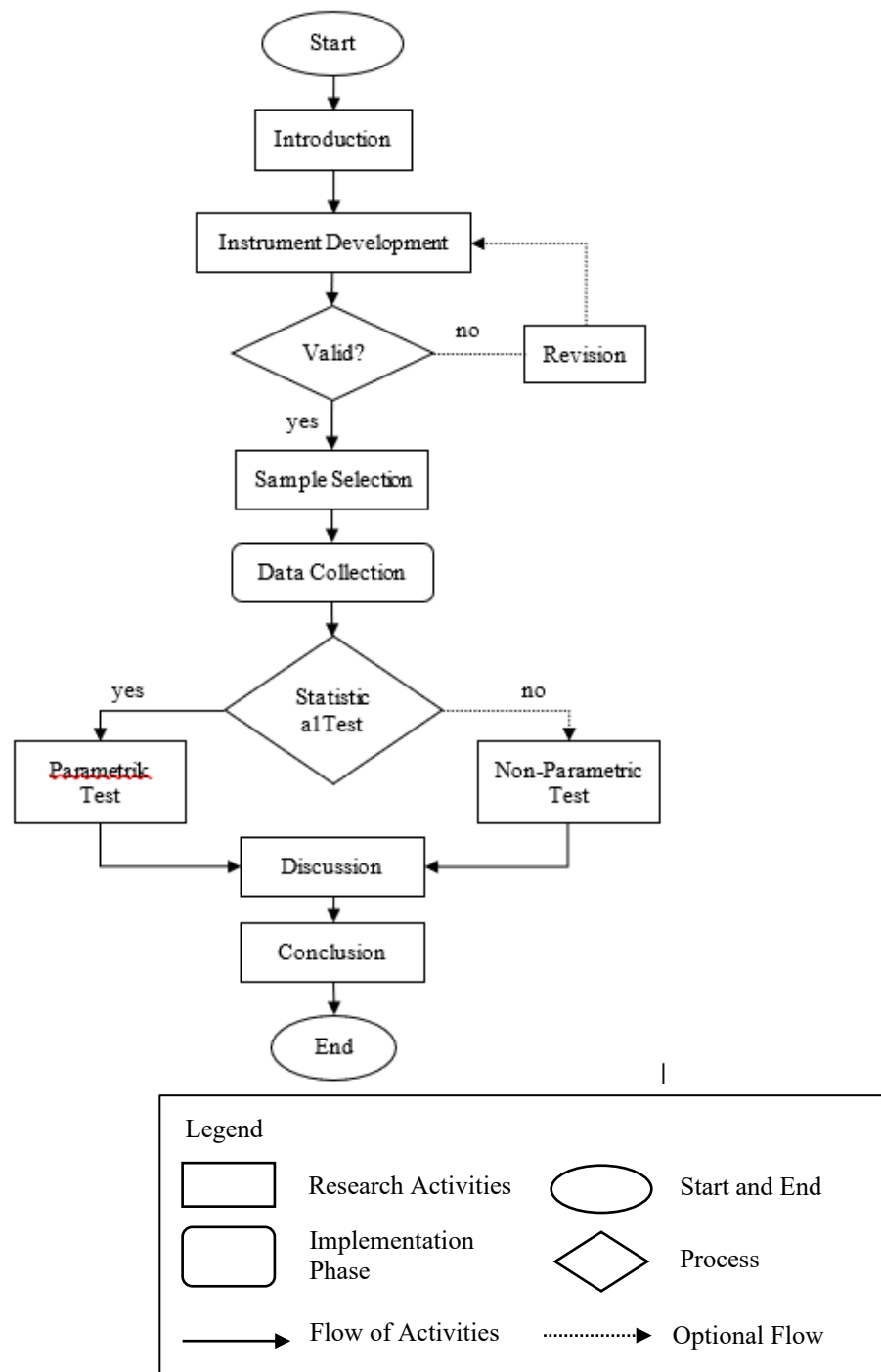


Figure 3. Research flowchart

3. Results

3.1 Classroom Implementation

The research was conducted in two distinct classes, a control class (VIII F) and an experimental class (VIII G), with each receiving a different pedagogical treatment. In the control class, the learning process followed a conventional model. The first meeting began with a pretest to measure baseline knowledge. In the subsequent meeting, the teacher delivered the statistics material using a lecture-based method, where students listen carefully, took notes, and were given the opportunity to ask questions if they did not understand. The final meeting was dedicated to a 60-minute posttest to evaluate student comprehension after the conventional instruction.

In the experimental class, the learning process was designed to implement process differentiation based on learning styles. The activities also began with a pretest, which was followed by a non-cognitive diagnostic assessment of map student learning styles. The assessment results revealed an imbalanced distribution of learning styles among the 29 students, as presented in Table 4.

Table 4. Summary of Diagnostic Assessment Results

Learning Styles	Frequency	Group
V (visual)	15	3
A (auditori)	6	1
R (read/write)	5	1
K (kinesthetic)	3	1

The assessment revealed an imbalanced distribution of learning styles among the 29 students: 15 students were Visual, 6 were Auditory, 5 were Read/Write, and 3 were Kinesthetic. To manage the large number of visual learners, they were divided into three smaller groups, while other styles formed their own groups.

The second meeting began with the teacher posing a contextual problem to orient the students, such as, "What is the most frequent math score in this class?". Following this, each group received a Student Worksheet with a data collection task tailored to their learning style: the Visual group observed student shoe sizes, the Auditory group interviewed peers about their weight, the Read/Write group collected written data on exam scores, and the Kinesthetic group directly measured student heights.



Figure 4. Student Data Collection Process

After collecting and discussing the data within their groups, representatives from each group presented their findings to the class, with the teacher facilitating a wider discussion and providing feedback. The third and final meeting was allocated for a 60-minute posttest.



Figure 5. Presentation of Observation Results

3.2 Quantitative Analysis Results

The initial stage of data analysis is to conduct statistical prerequisite tests. These tests are performed to ensure that the research data meets the necessary requirements and aligns with scientific assumptions, allowing for further analysis. The statistical prerequisite tests consist of a normality test and a homogeneity test. The data subjected to these prerequisite tests include the pretest and posttest results from the experimental and control classes. The descriptive analysis of the pretest and posttest results can be seen in Table 5.

Table 5. Descriptive Analysis of Test Scores for the Experimental and Control Classes

Descriptive Statistics	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation
Experimental Pre	29	9	1	10	146	5.03	3.041
Experimental Post	29	6	6	12	296	10.21	2.226
Control Pre	29	12	0	12	144	4.97	3.803
Control Post	29	4	8	12	286	9.86	1.481
Valid N (listwise)	29						

The first prerequisite analysis conducted was the normality test, using the Shapiro-Wilk method. The results of the normality test can be seen in Table 6.

Table 6. Normality Test Results for Pretest Scores

Tests of Normality	Class	Shapiro-Wilk		
		Statistic	df	Sig.
Results	Pretest Experimental Class	.894	29	.007
	Pretest Control Class	.895	29	.007

a. Lilliefors Significance Correction

Based on Table 6, the significance (sig.) values for the pretest data of each class were 0,007 and 0,007, respectively. Since the normality test results for the pretest scores of the experimental and control classes are less than 0,05 ($p\text{-value} < 0,05$), the null hypothesis (H_0) is rejected. Therefore, it can be concluded that the data is not normally distributed. The next prerequisite analysis was the homogeneity test, for which Levene's test was used. The results of the homogeneity test can be seen in Table 7.

Table 7. Homogeneity Test Results for Pretest Scores

Test of Homogeneity of Variances		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	.020	1	56	.888
	Based on Median	.017	1	56	.896
	Based on Median and with adjusted df	.017	1	40.942	.896
	Based on trimmed mean	.033	1	56	.856

The sig. value obtained from Table 7 is 0,888. Because this value is greater than 0,05 (p-value > 0,05), the null hypothesis (H_0) is accepted, meaning the data is homogeneous. Based on the homogeneity test results in Table 8, it was found that the pretest data for the experimental and control classes are homogeneous or have equal variances. Next, statistical prerequisite tests were conducted on the posttest data from the experimental and control classes. The results of the normality test for the posttest scores can be seen in Table 8.

Table 8. Normality Test Results for Posttest Scores

Tests of Normality	Class	Shapiro-Wilk		
		Statistic	df	Sig.
Results	Posttest Experimental Class	.741	29	.000
	Posttest Control Class	.860	29	.001

a. Lilliefors Significance Correction

Based on Table 8, the Sig. values for the posttest data of each class were 0,000 and 0,001, respectively. Because the normality test results for the posttest scores of the experimental and control classes are less than 0,05 (p-value < 0,05), the null hypothesis (H_0) is rejected. Thus, it can be concluded that the data is not normally distributed. The subsequent prerequisite analysis was the homogeneity test, using Levene's test. The results can be seen in Table 9.

Table 9. Homogeneity Test Results for Posttest Scores

Test of Homogeneity of Variance		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	3.238	1	56	.077
	Based on Median	3.255	1	56	.077
	Based on Median and with adjusted df	3.255	1	47.708	.078
	Based on trimmed mean	3.268	1	56	.076

The sig. value obtained from Table 9 is 0,077. Because the Sig. value of 0,077 is greater than 0,05 (p-value > 0,05), the null hypothesis (H_0) is accepted, meaning the data is homogeneous. After conducting the prerequisite analysis, it was found that the research data is not normally distributed but is homogeneous. Therefore, it does not meet the requirements for a parametric statistical test. Thus, to ascertain the improvement between the pretest and posttest scores within the group, a non-parametric statistical test, the Wilcoxon Signed-Rank Test, was employed.

Based on Table 10, the 'Negative Ranks' (representing a negative difference between pretest and posttest scores) for the control class, which received conventional instruction, show an N of 2, a Mean Rank of 5, and a Sum of Ranks of 10. The N of 2 indicates that two students in the control class experienced a decrease in their scores from the pretest to the posttest. The Mean Rank of 5 represents the average rank of this decrease, while the Sum of Ranks of 10 is the total of these ranks. In contrast, for the experimental class, which received differentiated instruction, the 'Negative Ranks' for N, Mean Rank, and Sum of Ranks are all 0. This indicates that no students in this group experienced a decrease in their scores from the pretest to the posttest.

Table 10. Wilcoxon Signed-Rank Test Results (Ranks)

	Ranks	N	Mean Rank	Sum of Ranks
Experimental Class <i>Pre – Post</i>	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	29 ^b	15.00	435.00
	Ties	0 ^c		
	Total	29		
Control Class <i>Pre – Post</i>	Negative Ranks	2 ^d	5.00	10.00
	Positive Ranks	26 ^e	15.23	396.00
	Ties	1 ^f		
	Total	29		

Furthermore, Table 10 shows the 'Positive Ranks' (the positive difference between pretest and posttest scores). For the control and experimental classes, the N values are 26 and 29, respectively. The N of 26 for the control class indicates that 26 students experienced an increase in their scores, with a Mean Rank of 15,23 and a Sum of Ranks of 396. Meanwhile, the N of 29 for the experimental class indicates that all 29 students who received differentiated instruction showed an increase in their scores, with a Mean Rank of 15 and a Sum of Ranks of 435. The basis for the decision on the Wilcoxon Signed-Rank Test can be seen in Table 11.

Table 11. Wilcoxon Signed-Rank Test Results (Asymp. Sig. / Asymptotic Significance)

Test Statistics^a	8G Pre - 8G Post	8F Pre - 8F Post
Z	-4.724 ^b	-4.403 ^b
Asymp. Sig. (2-tailed)	.000	.000

a. Wilcoxon signed ranks test; b. Based on negative ranks.

Based on the results, it is known that the Asymp. Sig. (2-Tailed) value is 0,00. Since 0,00 is less than 0,05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. This means there is a significant internal increase between the students' pretest and posttest scores. Subsequently, the Mann-Whitney U test was used to compare the posttest scores between the experimental and control classes. The results of the Mann-Whitney test can be seen in Table 12.

Table 12. Mann-Whitney Test Results

Test Statistics^a	Result
Mann-Whitney U	332.000
Wilcoxon W	767.000
Z	-1.436
Asymp. Sig. (2-tailed)	.151

Based on Table 12, it was found that the Asymp. Sig. (2-tailed) value is 0,151. Since this value is greater than 0.05, the null hypothesis (H_0) is accepted. Thus, it can be concluded that there is no significant difference between the posttest scores of the experimental and control classes.

4. Discussion

This study aims to describe the implementation and effects of process-differentiated instruction based on VARK learning styles. The findings present a nuanced picture: while the quantitative analysis showed no statistically significant difference in learning outcomes between the experimental and control groups, it did reveal significant learning gains within the experimental group, a finding strongly supported by positive qualitative student feedback from interviews. This discussion will interpret these findings by addressing the three guiding research questions.

Student Interview Results

P101: *“What do you think about the learning activities you've participated in over the last few meetings, especially when you were grouped based on learning styles?”*

R101(Visual): *“I enjoyed being able to learn through pictures and diagrams. Although collecting data was a bit difficult, presenting it became easier. Furthermore, when I was grouped with friends who had similar learning styles, I felt more comfortable in discussions, making it easier to grasp the material.”*

R201(Auditory): *“I think it's really good, because I can focus more on listening to my friends' explanations, especially when discussing together, I understand more because I often chat about the material together.”*

R301(Read/write): *“I feel very comfortable because my group does more reading and writing, so we can exchange summaries. So, I understand better because I get more writing practice.”*

R101(Kinesthetic): *“I really like learning while practicing, so I can more easily understand the concepts being taught, because I don't just sit still and listen to the explanation in front.”*

The first research question asked whether a significant difference existed between the differentiated and conventional groups. The primary quantitative finding was that there was no statistically superior outcome for the differentiated instruction group ($p = 0.151$). This outcome contrasts with the findings of some previous research cited in the introduction, such as that by [Siburian et al. \(2022\)](#) and [Bulu \(2023\)](#), which found a direct positive effect on problem-solving and learning outcomes. These findings differ from those of [Lai et al. \(2020\)](#), who found that differentiated instruction enhanced students' mathematics self-efficacy, learning motivation, and problem-solving skills. The absence of a statistically significant difference between the experimental and control groups in the present study may be related to the short intervention period of only three meetings, which may have been insufficient to produce a significant advantage over conventional instruction. However, it is important to note that many interventions are successfully implemented over longer periods of time, for example over a 12 weeks period. Therefore, a key factor that could explain this finding is the short duration of the intervention (three meetings). It is plausible that this timeframe was insufficient for the pedagogical shift to translate into a statistically significant advantage over the conventional method. However, based on the interview results, all students from each VARK learning style said they felt comfortable learning because it suited their style.

The second research question concerned the change in students' abilities after the intervention. Here, the findings were unequivocally positive. The Wilcoxon Signed-Rank test confirmed a highly significant improvement from pretest to posttest for the experimental group, with all 29 students demonstrating progress. This demonstrates that differentiated activities were indeed effective learning tools. The active, hands on, and contextualized nature of the tasks such as collecting and analyzing real world data provided a concrete pathway for students to understand abstract statistical concepts. This finding aligns with other research indicating that DI can enhance engagement, motivation, and academic achievement ([Olusegun & Blessing, 2024](#)), as well as foster a sense of ownership and participation in the learning process.

Finally, the third research question addressed the students' responses and learning experiences, where the most compelling effects of differentiated instruction were observed. The interview data provides rich evidence of a positive impact on student engagement and perception. For instance, a visual learner stated, “I was happy because I could learn through pictures and diagrams being grouped with friends who have the same learning style made it easier to discuss and grasp the material”. This feedback reflects how tailoring instruction to learning styles can increase engagement ([Olusegun & Blessing, 2024](#)). A kinesthetic learner

expressed similar enthusiasm: "I really like learning while practicing, so I can more easily understand the concepts being taught because I'm not just sitting still and listening". This statement affirms findings that hands-on activities effectively boost engagement and information retention for kinesthetic learners ([Sockanathan & Tajuddin, 2025](#)). This direct feedback strongly supports the findings of previous research by [Winahyu et al. \(2024\)](#) and [Arantini et al. \(2024\)](#), which linked differentiated instruction to increased motivation and active participation. The intervention's main value lies in fostering positive affective learning experiences and creating an engaging classroom environment. In conclusion, while process differentiation based on learning styles did not produce statistically superior test scores in this short-term study, its value was profoundly evident in the learning process itself. It successfully promoted understanding and significantly improved the student learning experience. The study is limited by its short duration and single-school context, suggesting that future research should explore the longitudinal impact of such interventions.

5. Conclusion

Based on the data analysis and discussion, this study draws three main conclusions in response to the research questions. First, there was no statistically significant difference in statistical problem-solving abilities between the experimental group, which received process-differentiated instruction, and the control group, which received conventional instruction, as indicated by the Mann-Whitney U test ($p = 0,151 > 0,05$); therefore, the null hypothesis was not rejected. This finding may be attributed to the short intervention period of only three meetings, which may have been insufficient to produce a statistically significant difference between the groups. Nevertheless, interview findings indicated that students across all VARK learning styles felt comfortable with the learning process because it aligned with their preferred learning styles. Second, students in the experimental group demonstrated an improvement in statistical problem-solving abilities following the implementation of process-differentiated instruction. The Wilcoxon signed-rank test indicated a statistically significant pretest-posttest difference ($p = 0,000 < 0,05$), with all 29 students showing an increase in their scores. This finding suggests that learning activities tailored to students' VARK learning preferences may support the development of their understanding and problem-solving skills. Third, students responded positively to the implementation of process-differentiated instruction, reporting greater engagement, motivation, and enjoyment during learning. Interview data further revealed that students felt more connected to the learning materials when the learning process was aligned with their VARK preferences (Visual, Auditory, Read/Write, and Kinesthetic). Overall, these findings suggest that the intervention's benefits were reflected not only in improvements in students' problem-solving scores but also in their positive learning experiences.

6. References

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