The Impact of Student-Oriented Worksheets for Differentiated Learning (LKPD) on Students' Physics Learning Outcomes at MAN Binjai

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Abstract *- The study aims to determine the effect of differentiated learning using learning style-oriented Student Worksheets (LKPD) on student learning outcomes in sound wave material at MAN Binjai T.P 2022/2023. This type of research is quasi-experimental, and the research design is a Control Group Pre-Test-Post-Test Design with a population of all students of class XI MIA MAN Binjai consisting of 4 classes. The research sample was taken by two classes determined by random sampling technique, with XI MIA-3 as the experimental class, totaling 35 people who were treated with differentiated learning using learning style-oriented worksheets, and the control class XI MIA-4, totaling 35 people who were given inquiry learning treatment. The instrument used was a multiple-choice test of learning outcomes with 15 validated questions and student learning activity assessment sheets in the experimental class. The results of the data analysis obtained an increase in student learning outcomes in the experimental class of 73.71 and the control class of 65.33. In addition, the increase in student activity in each meeting was very good. After implementing differentiated learning using learning style-oriented worksheets, the results significantly affected student learning outcomes in sound waves material at MAN Binjai T.P 2022/2023.*

Keywords: *Differentiated Learning; LKPD; Learning Styles; Learning Outcomes*

INTRODUCTION

In 2022, Indonesia's education quality index remains in the moderate range, indicating room for improvement in the country's educational system (Agustina et al., 2022). Despite efforts by the Indonesian government to enhance instructional standards, including curriculum reforms aimed at aligning education with students' needs (Wiguna & Tristaningrat, 2022), there is still a prevalent belief among teachers in various parts of Indonesia that all students share the same traits (Andini, 2016).

This misconception persists even when dealing with classrooms of over 20 students. Students exhibit various characteristics, including ethnicity, culture, social status, interests, cognitive development, prior knowledge, motivation, emotional and social development, and learning styles (GTK Dikdas Team, 2021). This study mainly centers on student learning styles.

Learning style refers to an individual's unique approach to acquiring and processing new information. Wiedarti (2018) cited that Neil Fleming popularized multiple learning styles, including visual, auditory, reading or writing, and kinesthetic. Students may prefer a different learning approach; some might combine several styles.

In physics education, it is crucial to accommodate students' learning preferences by presenting material that suits their needs (Halim, 2012). For example, visual learners benefit from diagrams and images, auditory learners from verbal explanations, and kinesthetic learners from hands-on activities (Said & Budimanjaya, 2015). Engaging students in practical and experimental activities also fosters a deeper understanding of physics concepts and necessary practical skills (Halim, 2012).

Please accommodate these preferences to avoid student discomfort and decreased interest in learning (Ivenna, 2019). Students may need help comprehending material presented in an incompatible style, affecting their motivation. To optimize learning outcomes, teachers and educational institutions must understand students' learning preferences and adapt accordingly (Pratama, 2020).

At MAN Binjai, Mr. Zul Azhar, a physics teacher, noted that students exhibited varying levels of understanding in physics, often needing more than the KKM score. The teachers' limited knowledge of students' learning preferences is a key reason, as they often focus on ethnicity, culture, and social status. When surveyed, students revealed distinct learning styles: 30.30% auditory, 28.18% kinesthetic, 28.19% reading, and 22.73% visual. These differences imply that students absorb subject matter differently. However, some physics instructors at MAN Binjai still need to adapt their instruction to cater to these diverse learning preferences.

Differentiated learning, which supports students' individual learning preferences, allows teachers the flexibility to tailor their instruction ((Fitra, 2022; Taylor, 2017)). It accommodates variations in students' skills, interests, and learning preferences by offering various learning strategies, such as visual, auditory, and kinesthetic.

Differentiated learning, introduced by Tomlinson in 2001, strives to modify classroom learning to cater to each student's needs (Tomlinson, 2001). Teachers offer diverse learning opportunities and approaches to empower students to learn in the way that suits them best.

For physics, Student Worksheets (LKPD) support differentiated instruction, encouraging independent and structured learning (Surat, 2019). LKPD should adhere to the physics curriculum, provide clear and structured information, and include challenging exercises (Izzatunnisa et al., 2019).

To further support differentiated learning, LKPD can be customized to accommodate students' diverse learning preferences (Chetty et al., 2019). For instance, worksheets designed for kinesthetic learners may include hands-on experiments. Differentiated learning using tailored LKPD has been shown to improve student learning outcomes in physics (Suhaeri & Daud, 2022; Yulianti, 2021; Awal & Sutriana, 2017).

In conclusion, differentiated learning with customized LKPD can enhance physics learning, but its success also relies on teachers' ability to recognize students' learning preferences and provide suitable instructional materials. Based on this background, the study "The Impact of Student-Oriented Worksheets for Differentiated Learning (LKPD) on Students' Physics Learning Outcomes at MAN Binjai" was initiated.

RESEARCH METHODS

It is a quantitative study with a quasi-experimental design because it is difficult for researchers to control external variables that influence experiment implementation. Sugiyono (2013) claims that quasi-experimental research is utilized when scientists want to understand the impact of independent variables on the dependent variable under carefully monitored circumstances. Other than the predetermined independent variables, no external variables influence the dependent variable in this situation.

This research involved class XI students at MAN Binjai City, in the even semester of the 2022/2023 academic year, as the research population. The samples taken consisted of two classes from four classes, namely class XI MIA-3 as the experimental group and class XI MIA-4 as the control group. Each class consists of 35 students. The sampling process uses the simple random sampling method, which means that the sample is chosen randomly without considering strata in the population (Sugiyono, 2013). In this study, the population is considered homogeneous by considering that students are at the same level, study material based on the same curriculum, and there is no superior class that differentiates them.

The research design used was the Control Group Pre-Test-Postest Design. According to (Sugiyono, 2013), in this design, the experimental and control groups were selected randomly and then given a Pre-Test to evaluate the initial conditions and see if there was a significant difference between the experimental and control groups. In this context, a good Pre-Test result is if there is no significant difference between the experimental and control groups' values.

Table 1. Control Group Pre-Test-Post-Test Design

Class	Pre-Test	Handling	Post-Test
Experiment	T_1	X	T_2
Control	T_1	Y	T_2

Information:

T1: Pre-test given to experimental class and control class before treatment

T2: Post-test is given after treatment in the experimental class and control class

X: Differentiated learning using learning style-oriented LKPD

Y: Inquiry learning

Through administering this questionnaire, it was discovered that 32.86% of students had an auditory learning style, 48.57% had a visual learning style, and 18.57% had a kinesthetic learning style.

In this study, the research instruments that the researchers validated were the initial test (Pre-Test) and the final test (Post-Test). The pre-test measures students' initial knowledge before being given special treatment. At the same time, the Post-Test is given to measure the knowledge of student learning outcomes after being given special treatment. In this study, the special treatment was the application of differentiated learning using learning style-oriented worksheets. The form of the test used is a multiple-choice test of 15 questions adjusted to the indicators of student learning outcomes.

The cognitive, affective, and psychomotor domains are said to be the three domains that are the focus of the assessment of learning outcomes, according to Sudjana (2009). However, only the cognitive domain was examined when evaluating the learning outcomes in this study. It results from the desire to gauge students' understanding and mastery of the material being taught.

In this study, two observers conducted direct observations of student activity. Guidelines for observing student learning activities are provided for observers to use as a guide while they are watching. The observer will assign a score to each activity based on a predetermined category. According to the facts, scores are given by putting a check mark (√) in the relevant column. The table given contains information about the items that must be observed, as shown in Table 2.

Table 2. Guidelines for Scoring Student Learning Activities

Aspects observed	Observation Results			Explanation
	High	Moderate	Less	
Provide opinions for problem-solving				
Give feedback to others				
Do the tasks given				
Motivation in doing tasks				
Tolerance and willing to accept the opinions of other students				
Responsibilities as a member of the group				

(Sudjana, 2009)

Evaluation:
Assessment of aspects of student activity is carried out by giving a value of 1-3 in the column provided according to the facts experienced. The formula for determining the value of student activity, namely:

$$Student\ activity\ score = \frac{Score\ achieved}{Maximum\ score}\ x\ 100\%$$

(Sudjana, 2009)

Tabel 3. Student Activeness Research Achievement Indicators (Arikunto, 2017)

Percentage	Category
75%-100%	High
51%-74%	Moderate
25%-50%	Low
0%-24%	Very Low

RESULT AND DISCUSSION

Result

Pre-Test and Post-Test research data in the experimental class and control class, then the average value data, standard deviation and variance are obtained in Table 4.

The normality test was carried out on the Pre-Test and Post-Test data for the experimental and control classes using the Kolmogorov-Smirnov test method. The results of the Pre-Test and Post-Test data normality tests in both classes are stated in Table 5.

Table 4. Research Data Pre-Test and Post-Test Class Experiment and Control

No	Data	Averages	Standard Deviation	Variances
1	Pre-Test Experimental Data	53,33	12,62	159,47
2	Pre-Test Control Data	51,62	12,86	165,60
3	Post-Test Experimental Data	73,71	9,96	99,19
4	Post-Test Control Data	65,33	10,70	114,51

Table 5 shows the Pre-Test and Post-Test normality values for both classes, namely the experimental and control classes, with the price I_{Table}= 0.224 at a significant level α = 0.05 and n = 35. In the Pre-Test for the experimental class, the value I_{Count}=0.100 and in the Post-Test for the experimental class, the value I_{Count}=0.121. Whereas in the control class Pre-Test the value 〖I_{Count}=0.135 and in the control class Post-Test the value I_{Count}=0.119. With I_{Count} < I_{Table}, it can be concluded that the Pre-Test and Post-Test data in both classes are normally distributed.

Moreover, a Homogeneity Test was carried out on the Pre-Test and Post-Test data for the experimental class and control class using the F Test method (Similarity Test of two variances). The results of the homogeneity test calculations are shown in the table 6.

Table 5. Results of Data normalized test

Group	Pre-test Data		Post-test Data		Conclusion
	l_{Count}	l_{Table}	l_{Count}	l_{Table}	
Experiment	0,100	0,224	0,121	0,224	Normal Distributed
Control	0,135	0,224	0,119	0,224	Normal Distributed

Table 6. Homogeneity Test Results

No	Data	Variances	F_{Count}	F_{Table}	Conclusion
1	Pre-Test Experimental Data	159,477124	1,038407494	1,772066477	Homogeny
2	Pre-Test Control Data	165,602240			
3	Post-Test Experimental Data	99,1970121	1,15436747	1,772066477	Homogeny
4	Post-Test Control Data	114,509803			

Table 6 shows the Pre-Test and Post-Test homogeneity values in the experimental class and control class with prices F_{Table} = 1.772 at a significant level α = 0.05 and n = 35. In the experimental class Pre-Test and control class Pre-Test, the value F_{Count}= 1.038 was obtained. Whereas in the Post-Test experimental class and Post-Test control class, the price F_{Count} = 1.154 With F_{Count}<F_{Table}, it can be concluded that the Pre-Test and Post-Test data in both classes have a homogeneous variance.

If the Pre-Test and Post-Test data meet two requirements, namely normal distribution and homogeneous variation, then hypothesis testing can be carried out on the Pre-Test data. Hypothesis test calculations using Pre-Test data can be seen in Table 7 and 8.

Table 7. Hypothesis Test Results of Pre-Test Data

No	*Data*	Average Value	t_{Count}	t_{Table}	Conclusion
1	Pre-Test Experimental Data	53,33	0,5625	1,995	Accepted H_0
2	Pre-Test Control Data	51,62			

Before the treatment was given, there was no significant difference between the experimental and control classes in terms of students' basic abilities. So, it can be concluded that MAN Binjai differentiated learning with the LKPD learning style is superior to conventional learning in terms of student learning outcomes in sound waves.

Table 8. Hypothesis Test Results of Post-Test Data

No	Data	Average Value	t_{Count}	t_{Table}	Conclusion
1	Post-Test Experimental Data	73,71	3,39	1,66	Rejected H_0
2	Post-Test Control Data	65,33			

To see how much influence the independent variable has on the dependent variable, the effect size test is used. Effect size is a measure of the magnitude of the effect of a variable on other variables, the magnitude of differences or relationships, which is free from the influence of sample size.

$$Effect\ Size = \frac{(\bar{x}_{post}Eks - \bar{x}_{pre}Eks) - (\bar{x}_{post}Con - \bar{x}_{pre}Con)}{\frac{SD_{pre}Con + SD_{pre}Eks + SD_{post}Con}{3}}$$

$$Effect\ Size = \frac{(73{,}71 - 53{,}33) - (65{,}33 - 51{,}61)}{\frac{12{,}86 + 12{,}62 + 10{,}70}{3}}$$

$$Effect\ Size = \frac{6{,}66}{12{,}06}$$

$$Effect\ Size = 0{,}55 \rightarrow Kategori\ sedang$$

Differentiated learning using learning style-oriented LKPD influences students' physics learning outcomes in sound wave material at MAN Binjai from the effect size results.

Students' activities during the differentiated learning process using Student Worksheets (LKPD) that were customized to different learning styles in the experimental class were observed with the aid of an observer. Observers conducted this observation using observation forms of student activities that researchers had already created. From meeting 1 to meeting 3, the observation process was conducted during physics lessons on sound waves in classes XI MIA 3 and XI MIA 4. Table 7 provides details about student activities while learning.

Student activity scores increased from 69.68 at the first meeting to 81.58 at the second meeting. Then, the student activity score increased again to 89.52 at the third meeting. The increase in student activity was due to the teacher implementing a differentiated learning strategy assisted by learning style-oriented worksheets during the teaching and learning process. When studying, students can choose between several activities or assignments that suit their interests and learning styles. It gives a sense of ownership of learning so that student activities during learning can be considered active.

Table 7. Data from Observation Results of Experimental Class Student Activities

Student Activity	1st Meeting	2nd Meeting	3rd meeting
Provide opinions for problem-solving	63,80952381	81,9047619	84,76190476
Give feedback to others	66,66666667	80	89,52380952
Do the tasks given	71,42857143	80	94,28571429
	71,42857143	81,9047619	89,52380952

Student Activity	**1st Meeting**	**2nd Meeting**	**3rd meeting**
Motivation in doing tasks			
Tolerance and willing to accept the opinions of other students	73,33333333	83,80952381	89,52380952
Responsibilities as a member of the group	71,42857143	81,9047619	89,52380952
SCORE	**69,68253968**	**81,58730159**	**89,52380952**
Criteria	**High**	**Very High**	**Very High**

Discussion

One of the objectives of this study was to assess the learning outcomes of students in the experimental class who received differentiated instruction using Student Worksheets (LKPD) focused on learning preferences. In contrast, the control class received traditional instruction. Students used the learning style questionnaire instrument to determine their unique learning styles at the start of the study. The researcher then used the LKPD, which was created based on each student's learning style. Two groups of students participated in the study and used different learning strategies. Worksheets geared toward different learning styles were used in the experimental class. While in the control group, students adhere to traditional teaching methods without considering their individual learning preferences.

According to the research findings, The control and experimental classes have different learning outcomes. According to the average physics learning outcomes, the results showed that the experimental class, which used worksheets based on learning styles, outperformed the control class regarding learning outcomes. According to this study, the average learning outcomes in physics for students who received differentiated instruction using worksheets tailored to their learning styles were 73.71, compared to 65.33 for students in the control group.

The results of this study also aim to observe student activity during differentiated learning using worksheets oriented toward student learning styles in the experimental class. In this study, it was found that students showed a high level of activity during differentiated learning using worksheets that were adapted to students' learning styles. In the experimental class, students are actively involved in the learning process. Using worksheets adapted to student learning styles makes students feel more involved and actively contribute to learning. When students are taught using a differentiated learning approach, they tend to engage more deeply in learning activities, feel valued, and are motivated because the material being taught considers their individual needs. It is in line with the opinion of Wahyuningsari entitled “Differentiated Learning in the Context of Realizing Freedom of Learning” that the impact of implementing differentiated learning is that every student with various characteristics feels welcomed and valued. The criteria for student learning motivation are interpreted as shown in Table 8.

Based on calculations, the student activity score increased from 69.68 at the first meeting to 81.58 at the second meeting. Then, the student activity score increased again to 89.52 at the third meeting.

Table 8. Student Activity Criteria

Presentation	Category
80%-100%	Very high
65%-80%	Tall
55%-65%	Currently
40%-55%	Low
0%-55%	Very low

Using the visual worksheets provided, students with a visual learning style can comprehend the subject matter by using their visual assets. When information is presented orally, students with auditory learning styles find it more straightforward to comprehend and remember. Students can benefit from their strengths in hearing-based learning by using the auditory LKPD that has been provided. On the other hand, kinesthetic learners frequently use their bodies to learn. They can take part in bodily movement-based physical experiments. Students can give a stimulus that fits their learning style to the material by using kinesthetic worksheets to help them understand it. Students can study how they prefer to learn with worksheets tailored to different learning styles. It can encourage students to participate in each learning activity and improve their comprehension of the course material (Arestu et al., 2018). It concurs with Evalina's assertion entitled "Efforts to Increase Student Activities and Learning Outcomes through the Use of Problem-Based Learning Model" that LKPD can enhance student learning activities while the teaching and learning process is in progress.

There are a number of challenges in conducting this research, even though differentiated learning using learning style-oriented LKPD can positively influence student learning outcomes and student activity in the classroom, which is superior to inquiry learning. Researchers need to use time efficiently, which makes the entire learning process less effective. For future researchers, it is recommended to improve classroom management further to create a conducive classroom atmosphere. It is also essential to organize learning tools and teaching materials as well as possible so that the learning process becomes more effective. For future researchers, involving more than one observer in observing students during the learning process is recommended. Due to the large number of students, more effective and in-depth monitoring is required to make research results more accurate and representative.

CONCLUSION

Based on the results of data research and statistical tests, it can be concluded, Firstly, $T_{Count} > T_{Table}$ where 3.3917> 1.6675, which means that the application of differentiated learning using learning style-oriented worksheets is better than the application of inquiry learning to student physics learning outcomes in sound wave material at MAN Binjai. Secondly, the results of student activities in differentiated learning using learning style-oriented worksheets are relatively high at each meeting, based on observation by observers who get the average results of student activity.

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