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The influence of academic ability and learning styles on learning outcomes in differentiated instruction

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ABSTRACT

Applying students' learning styles and academic abilities often poses a challenge in the differentiated learning process. This study investigates the influence of learning styles and academic ability on student learning outcomes in the differentiated learning process of plant and animal reproduction material. With the quasi-experimental method and pretest-posttest control design. The subjects of the research were ninth-grade students at UPTD SMPN 1 Losarang. Learning style data, the academic groups of students from the pre-test results in the high ability group predominantly having an auditory learning style, the middle ability group predominantly having a kinesthetic learning style, and the low ability group predominantly having a visual learning style. There is no influence of learning style on learning outcomes of 2.9%. There is a positive and significant influence of academic ability on learning outcomes of 48%. There is a positive and significant influence of learning style and academic ability on learning outcomes of 49.8%. The T-test for the experimental and control classes produced output Pair 1 with a sig value of 0.000 < 0.05, meaning there is an influence of learning styles and academic ability on student learning outcomes in differentiated learning before and after treatment.

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INTRODUCTION

The current learning and teaching process has challenges in meeting the increasingly diverse needs and interests of each student, so teachers have a very important role in accommodating this diversity through the implementation of different learning methods (Insani et al., 2023). In this increasing diversity of students, teachers are required to be able to respond appropriately to various learning needs, applying different teaching approaches to achieve optimal learning outcomes (Pozas et al., 2020).

The results that students achieve during learning activities, which include cognitive, emotional, and psychomotor aspects, are known as their learning outcomes. These results are usually assessed with a numerical test, which shows how well students understand the Lesson (Ali, 2022). One factor is that students' learning styles affect these outcomes. Students who have a certain learning style, if the learning activities obtained are not suitable, it will hurt their learning outcomes (Rofifah and Nasith, 2023). A student's academic ability is a multifaceted construct influenced by a variety of factors, including cognitive skills, educational environment, and institutional support. Different academic abilities correlate with learning outcomes, which shows the need for learning strategies that are tailored to the learning needs of different students (Ardi et al., 2021; Kaur and Prajapati, 2022).

Educational differentiation is defined as a teaching strategy that adapts teaching to meet the diverse learning needs of students, taking into account the characteristics, abilities, interests, and learning styles of each with the aim of creating an effective learning environment for students that can foster academic growth and success (Azmy & Fanny, 2023; Syahfitri, 2023; Yani et al., 2023).

The Independent Curriculum introduces a new learning paradigm, namely, independent learning. This approach allows students to choose a subject that suits their interests and needs. The application of this approach is carried out in several stages, including the stages of planning, implementation, and reflection (Subkhi et al., 2023; Nafiah, 2024). In its implementation, this approach requires a curriculum adjustment strategy based on student readiness, interests, and profiles to increase motivation and involvement in the learning process to accommodate the diverse needs of each student. One of the effective strategies includes utilizing project-based learning (PJBL) and integrated problem-based learning (PBL), which have been proven to significantly improve students' critical thinking skills and techniques collectively, as well as accommodate students' diverse learning styles (Hindriana & Sulistyono, 2023; Kurniawan & Sabaruddin, 2023; Qurratu'ain et al., 2024). Therefore, this approach not only improves academic performance but also supports students' holistic development in diverse learning environments and experiences (Devi, 2023; Suarni et al., 2023).

Various studies have been conducted on different learning. Some of them, such as those carried out by Aprima and Sari (2022), and Avandra (2022), show that differentiated learning can improve students' critical thinking skills. Qomari et al. (2022) and Sitanggang and Ruslan (2022) also found that this method can contribute positively to student learning outcomes. In addition, research by Hanaunnadiya et al. (2023) and Astuti and Afendi (2022) shows that students who engage in a variety of learning activities experience significant performance improvements compared to their pre-test scores. Other interesting findings, as reported by London (2022), state that students can respond well to the learning activities given and are aligned with their learning styles, providing evidence that this approach has a positive impact on learning outcomes.

Differentiated learning applied through a cooperative approach provides students with the opportunity to learn collaboratively in structured tasks. In the context of cooperative learning, students not only become active participants but also act as a learning resource for their peers. This concept is based on the belief that the learning process will be more meaningful if students teach each other. Although students can gain knowledge from two main sources, teachers and classmates, the experience of interaction in cooperative groups allows them to share knowledge and many ideas in solving problems presented by teachers (Hasanah & Himami, 2021).

Grouping students into teams of individuals with different abilities sometimes results in unexpected dynamics. Students with lower abilities often become less active and more dependent on their more diligent peers, causing more capable students to tend to dominate group assignments. Although grouping can improve student performance, heterogeneous groups show better results

compared to homogeneous groups. A study shows that students feel more satisfied in homogeneous groups (Tan & Dimmock, 2022).

The concepts of learning styles, homogeneous groupings, and differentiated teaching implementation have been identified as lacking in studies that systematically combine these three concepts to understand how students' learning styles can affect the success of the learning process and the improvement of expected learning outcomes by considering the grouping of abilities. By integrating these three concepts, it is hoped that students' learning styles can be identified and grouped according to their academic abilities.

RESEARCH METHODS

Research Design

This study uses a quasi-experimental method with a factorial design to examine the influence of academic ability (high and low) and learning style (visual, auditory, and kinesthetic) on student learning outcomes by comparing experimental classes and control classes. The independent variables in this study are Learning Style (X1) and Academic Ability (X2), and the dependent variable is student learning outcomes (Y) using a differentiated cooperative learning approach. The initial stage in the analysis of student data, this study uses a pre-test-posttest control design with group A as the experimental class and group B as the control class. The research design is presented in Table 1.

Table 1. Pretest-posttest control design research design (Herwina et al, 2021)

Group (R)	Pre-test	Treatment	Post-test
Experimental Class	O_1	X_1	O_2
Control Class	O_1	X_1	O_2

Population and Samples

The research was conducted at UPTD SMPN 1 Losarang, Indramayu Regency, from October 28 to November 23, 2024. The research subjects were Grade IX junior high school students, totaling 160 individuals who had the best level of understanding of the material that had been given previously. The sample was divided into two groups, namely the experimental and control groups. The research procedure was carried out in four (4) stages, including direct observation, preparation of the instrument creation, instrument validity testing, and implementation.

Instruments

The instrument in this study is a test on the subject of Natural Sciences (IPA) in the material Plant and animal breeding in the form of multiple-choice questions totaling 25 out of 30 questions based on the C1-C6 component which is tested for validity and a reliability test with a value of 0.876 which is classified as very high to measure how feasible these questions are to be used in research. These questions are used in the pre-test and post-test to measure the influence of academic ability and student learning style on learning outcomes.

Procedures

The research process begins with a silent observation at UPTD SMPN 1 Losarang, Kabupaten Indramayu, to identify the students' characteristics and the state of the classroom at the beginning of the study. The validity and reliability of the research instruments, which are learning outcomes and learning attitudes, are then evaluated. Using the purposive sampling technique, the study sample consisted of approximately 62 students from Grade IX out of 160 total students.

Sampel is then divided into two groups, namely the experimental group and the control group. Pre-tests are given to both groups to determine the students' initial proficiency before work begins.

The experiment consists of a variety of cooperative learning activities that are tailored to the learning styles of the students (visual, auditory, and kinesthetic) and academic aptitude (ability grouping). The "Aku Pintar" app is used to identify learning styles. Following a successful learning process, two groups are given post-tests to gauge the improvement in learning outcomes. The data obtained from the analysis is subjected to validity and reliability checks, normality checks, T (paired and independent sample) checks, and linear regression analysis to determine the impact of the dependent variable on learning outcomes. The research procedure is presented in Figure 1.

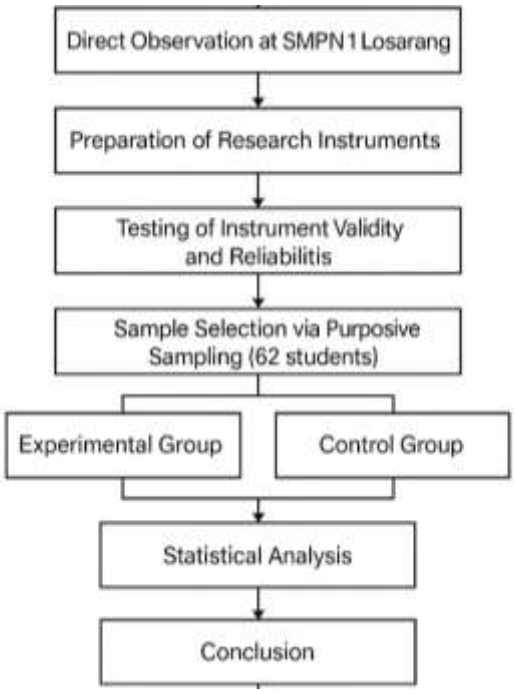


Figure 1. Research Procedures.

Data Analysis

Data analysis in this study used descriptive and quantitative analysis with linear regression to find the T-test value using the SPSS application to compare the averages of two groups, namely the experimental group and the control group, to see the influence of learning styles and academic ability (ability grouping) on learning outcomes using a differentiated learning approach.

RESULTS

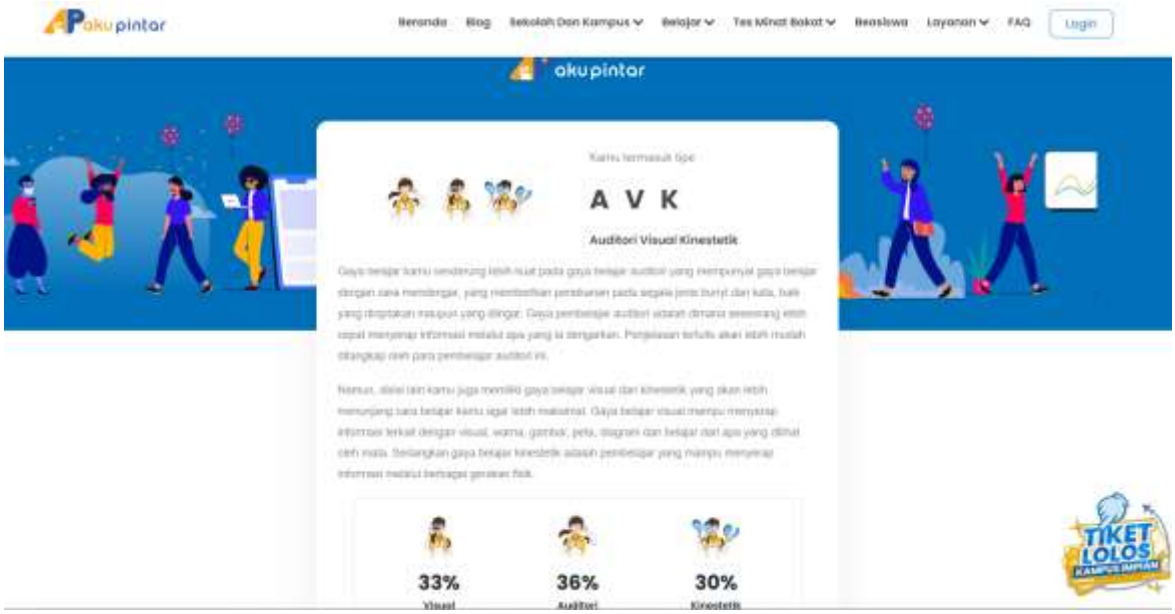
The pre-test results for the experimental group produced student groups with diverse academic abilities (ability grouping), namely groups with high ability, middle ability, and low ability. This result is presented in Table 2.

Table 2. Results of the pre-test in the experimental class of academic abilities

No	Academic Ability Group	Total
1	High Ability	6 Students
2	Middle Ability	10 Students
3	Low Ability	15 Students

Based on Table 2 shows the academic groups (ability grouping), namely the High Ability group consisting of 6 people, the Middle Ability group consisting of 10 people, and the Low

Ability group consisting of 15 people. Then, these 3 groups underwent a learning treatment with a differentiated cooperative learning approach by taking a learning style test using the Aku Pintar



application, which contains 30 questions to be completed (Figure 2).

Figure 2. Userface of the Aku Pintar Application

After completing the questions, the results of the students' learning styles will automatically be displayed along with their percentages. The results of the analysis of students' learning styles are presented in Table 3.

Table 3. Results of Learning Style Test with the Aku Pintar Application in the Experimental Class

No	Learning Styles	Total
1	Auditory	8 Students
2	Visual	10 Students
3	Kinestetik	13 Students

Based on Table 3, it shows that students' learning styles are divided into 3 types: auditory (8 people), visual (10 people), and kinesthetic (13 people). The school that served as the research location consistently has an auditory learning style, which means that the learning process must be conducted in a challenging environment. After that, the students were given a post-test to see their learning outcomes compared to before the treatment was conducted. From that data, the calculation of the scores obtained by the students was then carried out, starting from the students' learning styles, academic ability (pre-test), and learning outcomes (post-test) presented in Table 4.

Table 4. Results of Calculation of Average Scores of Learning Styles, Academic Abilities, and Learning Outcomes of Students in the Experimental Class

The highest percentage results of learning styles from the Aku Pintar application (XI)	Pre-Test Academic Ability (X2)	Post-test Learning Outcomes (Y)
43	41	79

Data from Table 4 were then subjected to T-Test analysis, which included several stages of analysis, namely normality and residual tests, multicollinearity test, and heteroscedasticity test. The results of these analysis stages are presented in Table 5.

Table 5. Pre-test Results of T-Test Analysis

Variabel	Normality Test		Multicollinearity Test		Heteroskedasticity Test	
	Sig	Note	VIF	Note	Sig	Note
Learning Style Academic Ability Learning Outcomes	0,72	Normally Distributed	1,005	No multicollinearity occurred.	0,721	No Heteroskedasticity Occurs

The results of the pre-test analysis above show that the data is ready for calculating the T-Test is presented in Figure 3.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	64.540	15.729		4.103	.000
	Gaya Belajar (X1)	-.312	.336	-.125	-.929	.361
	Kemampuan Akademik (X2)	.680	.133	.685	5.101	.000

a. Dependent Variable: Hasil Belajar (Y)

Figure 3. Table of Coefficients

The t-test results show that the learning style variable ($X1$) does not have a significant effect on learning outcomes (t=−0.929, $Sig.$=0.361). On the other hand, the academic ability variable ($X2$) has a significant positive influence on learning outcomes (t=5.101, $Sig.$=0.000). This indicates that academic ability plays an important role in improving learning outcomes, while learning style does not have a significant impact in this model. These results are supported by the R value in the coefficient of determination (R-square: 0.029 and 0.48) for the two independent variables analyzed, which indicate that 2.9% of the learning outcomes are influenced by the learning style variable, while the remaining 97.1% is influenced by other variables. In contrast, the academic ability variable influences student learning outcomes by 48%, with the remaining 52% influenced by other variables outside the study (Figure 4). Then continued with the T-test analysis on the experimental class and the control class, with the analysis results presented in Figure 5.

(A)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.171[a]	.029	-.004	12.674

a. Predictors: (Constant), Gaya Belajar (X1)

(B)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.480	.462	9.276

a. Predictors: (Constant), Kemampuan Akademik (X2)

Figure 4. Determination Value (R-square), A. Learning Style, B. Academic Ability

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre-Test Eksperimen - Post-Test Eksperimen	-38.258	10.027	1.801	-41.936	-34.580	-21.245	30	.000
Pair 2	Pre-Test Kontrol - Post-Test Kontrol	-26.097	15.147	2.720	-31.653	-20.541	-9.593	30	.000

Figure 5. Results of the T-Test Analysis

Based on the analysis results in Figure 4, a comparison was made between the pre-test and post-test scores in two groups, namely the experimental class, which received treatment in the form of differentiated cooperative learning, and the control class, which did not receive any treatment. In the experimental class, the average score difference was −38.258 with a standard deviation of 10.027. The t-test value obtained is −21.245 with 30 degrees of freedom (df) and a significance value of 0.000. This indicates that there is a significant difference between the pre-test and post-test scores in the experimental class after the treatment was given. Meanwhile, in the control class, an average score difference of −26.097 with a standard deviation of 15.147 was obtained. The t-test value obtained was −9.593 with 30 degrees of freedom (df) and a significance value of 0.000. This shows that in the control class, although no treatment was given, there was an increase in post-test scores compared to pre-test scores, but the increase was smaller than in the experimental class. Both results show that the application of differentiated cooperative learning in the experimental class has a more significant impact on improving student learning outcomes compared to the control class, which did not receive treatment. This is evident from the larger average score difference and the higher t-test value in the experimental class. Thus, differentiated cooperative learning can be considered an effective method in improving students' learning outcomes.

DISCUSSION

The characteristics of auditory learning, the material be examined carefully, and during the teaching process, auditory learning is consistently applied in the classroom, with persistent note-taking during instructions, and carried out with timeliness and diligence. Prefer longer readings and demonstrations and oral explanations, have difficulty remembering oral instructions, and need to pay attention to the teacher's language and expressions to quickly and accurately understand the lesson (Irawati et al, 2021).

Then, students who learn visually are more likely to enjoy reading. This is in line with the characteristics of visual learning, particularly: Learning materials must be visible, students sometimes try to sit at the front of the class during the teaching and learning process, and sometimes students must pay attention to the teacher's words and expressions to understand the lesson being taught. Students must also be able to demonstrate their understanding of the material more effectively than when it is explained in class; they must be able to answer questions quickly and enthusiastically; and they must be able to understand the material well, orderly, and neatly (Irawati et al, 2021).

Kinesthetic Learning Style: Students usually excel in language activities. This aligns with the idea that students will find it easier to understand the material when they are engaged, active, and moving. This is why students who lack kinesthetic learning skills cannot understand the material through memorization. When they express opinions, they usually use body-related terms with hand movements and other body parts, such as the face and eyes. When they get bored, they move or distance themselves from the area, they study open practice materials, they understand what is being taught, they use real objects as learning tools, they use them as aids, they learn by doing, they often use body language, they are not good at writing, and they play sports (Irawati et al, 2021).

Students participate in the learning process with the help of resources provided by teachers and the school. The available facilities include laptops, Infocus projectors, open halls, gardens, classrooms, libraries, and audio systems. These facilities ensure that students learn with ease. Students who consistently have a visual learning style can increase their interest in learning, especially during the learning process at school. Students who use auditory learning methods are expected to concentrate to enhance the teacher's clarity and to help them understand the material; teachers use audio in their lessons. Additionally, students who consistently demonstrate kinesthetic learning always participate in the learning process and quietly work on tasks while they study. By acknowledging this, teachers must be able to understand each student's learning style and support them during the learning process at school. In addition, teachers are expected to use methods, strategies, or techniques that enhance the type of learning their students engage in. Meeting these students' needs will not negatively impact their learning outcomes.

Students with high abilities predominantly have an auditory learning style, meaning that in their learning process, they do not like distractions and are more serious when completing tasks. Auditory learners can receive and interpret information just by listening, making the learning process smoother. The auditory learning group is also academically superior, as stated in Alsarawi's (2024) research, which indicates that students with an auditory learning style tend to excel in managing information through listening and repetition. Therefore, teachers should provide more questions during the learning process because auditory learners prefer to repeat and summarize the information they have received. Auditory learners like sequences, repetition, and summaries, and they often tilt their heads when trying to recall a memory (Khasawneh, 2021; Jape et al., 2022; Liu et al., 2022).

Students with middle-level abilities have a dominant kinesthetic learning style, meaning they can learn well through collaboration with their study groups. They prefer hands-on learning and cannot stay still, so during the learning process, teachers provide freedom for kinesthetic learners to choose a comfortable learning environment for themselves. Therefore, the science learning process is not confined to a single location and is certainly contextual, in line with the research by Paynter et al (2023) and Hattan et al (2024), kinesthetic learners often have difficulty focusing on learning activities.

Students with low abilities predominantly have a visual learning style, making it easier for them to receive information by paying attention to what the teacher does, through demonstrations, role-playing, and using various visual media during learning. This is very suitable for low-ability groups. Teachers provide treatment by giving extra attention because students with a visual learning style need a special approach to receive information well. Everything the teacher does, visual students can remember well. Visual learners often use their hands to remember objects and look up when trying to recall something (Zhang et al., 2022; Park et al., 2023). So this learning style requires various models and teaching methods, emphasizing demonstrations (Kunze & Cromley, 2021).

The results of this study are the same as other studies, which show that students with high abilities generally have an auditory learning style and are good at managing information through listening. Students with intermediate abilities prefer kinesthetic learning through hands-on and cooperative activities. Meanwhile, students with low abilities tend to have visual learning styles and need additional help in the learning process (Pikri et al., 2020; Vittorazzi et al., 2020; Listyarini et al., 2023).

CONCLUSION

The teaching and learning process using cooperative learning and a differentiated approach results in group divisions based on academic levels, which have proven to be quite successful

because students feel comfortable learning as they receive attention from the teacher. Then, based on linear regression analysis and the T-test, there is a significant relationship between ability grouping and student learning outcomes at UPTD SMPN 1 Losarang. However, this study also shows that more effort is needed to improve the effectiveness of differentiated learning for students with high academic ability, so that the differences in learning outcomes become more apparent. The results of the study show that the application of cooperative learning with a differentiation approach based on academic ability is effective in increasing student comfort and involvement. Teachers need to continue to optimize this approach, especially in strengthening learning strategies for high-ability students, so that the difference in learning outcomes is more significant. Teacher training related to the implementation of differentiation is also important to increase the effectiveness of learning at various levels of ability.

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