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Differentiated Learning in Physics Lessons to Increase Creativity and Knowledge of Class X Students

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Abstract

Student learning outcomes are still low because the physics learning taught is not yet on target even though there are many factors that influence this because the teaching system is still focused in one direction. The aim of this research is to carry out differentiated learning according to students' learning styles so that students can be more creative in finding out the material provided by the teacher without any sense of compulsion, so that the learning that students undergo can be meaningful. This type of research is quantitative research with an experimental approach method. In this design, the researcher gives an initial test to both classes to determine the experimental and control classes before receiving treatment. The research sample was students of SMA Negeri 4 PPU class X.1 as the experimental class and class X.2 as the control class which was determined using non-random sampling techniques. The research data is in the form of a pretest, a diagnostic test to determine students' learning styles, creativity during learning and a posttest to determine students' physics knowledge. Validity data for creativity instruments and questions used Winstep software and for creativity used normality, homogeneity, Wicoxon and Mann Whitney tests, calculations were carried out using SPSS version 26 and Excel. The results obtained using the non-parametric test that the researcher carried out were (1) there was an effect of differentiated learning on students' creativity and knowledge of physics with a sig value. 0,000. (2) there are differences in student creativity and physics knowledge learning outcomes between the experimental class and the control class where the sig value is 0.000 <0.05. (3) Based on the results of research conducted by researchers using non-parametric tests, it can be concluded that classes that receive treatment are more effective in increasing their creativity and knowledge.
Keywords: *differentiation, creativity, knowledge*

Introduction

Education is a very important component in the formation and development of human resources in facing modern progress (Mardhiyah et al., 2021). As the times continue to advance rapidly, like it or not, there will be a need for a generation of quality humans. According to Hasibuan and Prastowo (2019), quality humans are humans who can compete in forming a critical, creative and innovative mindset, so to create good education, a process is needed. correct learning in every educational activity. Education is basically a strategic means to increase the nation's potential so that it is able to take part in a more global order as an investment in developing individual abilities..

In the world of education in Indonesia, there is a very influential figure in the world of education is Ki Hadjar Dewantara, he stated that the purpose of education is the process of guiding all the natural strengths that exist in students, so that they as humans and as members of society can achieve the highest safety and happiness (Sugiarta et al., 2019, Tarigan et al., 2022). Learning is the process of every living creature that is created to change and become

better, from those who cannot become able and from those who don't know to know until finally the living creatures created can discover their own characteristics (Nawafil & Junaidi, 2020).

Currently the government has implemented an independent curriculum for all levels of education in Indonesia, this curriculum is different from implementing curriculum 13. Curriculum 13 is a curriculum designed based on competency, namely the goal of the national education system which emphasizes the development of competencies, attitudes, knowledge and skills in an integrated manner without looking at differences in students' learning abilities. In the independent curriculum that we are currently facing, it is a curriculum designed to provide flexibility for educational units to create a contextual operational curriculum for educational units, so that learning is implemented in accordance with students' learning needs. This curriculum focuses on essential material and developing the character profile of Pancasila students (Muntatsiroh et al. al., 2023).

With the change in the learning curriculum in class x, it is very relevant if differentiated learning is implemented because maximum learning time is available. In addition to emphasizing students' knowledge, the independent curriculum for class The students of SMA Negeri 4 Penajam Paser Utara are actually students who already have good creative capital and so do their teachers, only because of the lack of time to understand the material in more depth and the teachers are not given the opportunity to get to know the characteristics of their students so the learning outcomes are sometimes less than optimal.

In general, students also need teaching methods that they can receive according to the characteristics of their learning style. Students who are used to seeing sometimes still find it difficult to accept what the teacher communicates, while students who tend to prioritize hearing will have difficulty understanding what the teacher writes in front of the class and students who tend to prefer moving will find it very boring to learn with sit nicely. This is what makes researchers carry out differentiated learning according to the learning styles of students so that students get their rights and obligations in gaining knowledge at school so that they will be able to understand learning without compulsion and arouse great curiosity by raising questions in in themselves.

Responsive teaching will create a classroom atmosphere that is conducive and lively in activities. The fact that students have diverse characteristics, with different uniqueness, strengths and learning needs, of course requires an appropriate response from the teacher, if there is no response from the teacher looking at the learning process then the activities will create gaps between students in learning. Where the achievements shown by students do not match the potential achievements that students should be able to demonstrate, one appropriate way for teachers to do this is to implement differentiated learning.

Differentiated learning is the right solution in carrying out this learning process because students have a variety of different environmental and cultural characteristics so that their treatment is also different in exploring their knowledge (Puspitasari & Walujo, 2020). According to Shihab (2015) differentiation is an activity that modifies processes, designs various activities to help students understand the material and modify products, and provides opportunities for students to show what they understand or learning outcomes through various forms. The application of differentiated learning methods can increase interest and response in the physics learning process (Suhartini, 2023). Teachers facilitate students according to their needs, because each student has different characteristics so they cannot be given the same behavior (Siagian et al., 2022).

Based on the reasons above, researchers will conduct research at SMA Negeri 4 Penajam Paser Utara by carrying out a learning process based on learning styles, students' readiness and interest in studying the energy content provided. Researchers want to foster students'

interest and sense of knowledge in discovering their own abilities in solving problems and finding solutions to the problems they face because learning in a real context and in accordance with their learning readiness is expected to foster students' creativity, interests and talents.

Method

This type of research is quantitative research with an experimental approach method. Experimental research is research that is used to see whether there is cause and effect for a treatment given to the experimental group and the control group as a comparison (Payadnya & Jayantika, 2018).

In this design, the researcher gave an initial test or pretest to both experimental and control classes before receiving treatment to determine students' physics knowledge. After that, the experimental class was given differentiated learning and the control class was given conventional learning, so at the end, after four meetings, a posttest was given to determine students' knowledge of physics, while to determine students' creativity, a formative assessment was carried out during learning.

Population is a very large amount of data and a wide range of possible people who are the object of research (Apriansah, et al 2024). The sample is the number of students who are the objects of this research, namely 2 classes where each class is a conventional learning control class and a differentiated experimental class consisting of 30 students in each class. Determination of the sample does not use random sampling but uses an existing population. This research was carried out in January 2024 in class X SMA N 4 Penajam Paser Utara.

In general, this section explains how the research was conducted. The main topics of this section are: (1) research design; (2) sample population or research subjects; (3) data collection techniques and instrument development; (4) and data analysis techniques. Please use descriptive paragraphs.

The data collection techniques used in the research are assessment of students' initial knowledge, diagnostic assessment or differentiation process and formative assessment. This research uses observation sheets in the learning process to see students' creativity with differentiated learning. Meanwhile, for the student knowledge instrument, researchers used a 10-item test with five alternative answers on energy content.

To investigate the effect of applying differentiated learning to increase students' creativity and knowledge of physics using a multivariate test, then proceed with a univariate test, namely the t test, to determine the variables that contribute to the overall difference. Data processing was carried out quantitatively with statistical tests, namely using normality, homogeneity tests, then using correlation tests to test the research hypothesis and continued with the Wilcoxon and Mann Whitney tests to determine whether there was an influence or not from the things being tested.

Results

Prerequisite Test

Basis for decision making in the normality test If Sig. (Significance) or probability value <0.05, then Ho is rejected and Ha is accepted, the data is not normally distributed while Sig. (Significance) or probability value > 0.05, then Ho is accepted and Ha is rejected and the data is normally distributed.

Table 1. Normality test

Variables	Class	df	Shapiro-Wilk Sig.
Creativity	Experimental Class	30	0,010

	Control Class	30	0,003
Physics knowledge	Experimental Class	30	0,004
	Control Class	30	0,038

Based on Table 1 of the normality test, it is known that the significance value for creativity in the experimental class is 0.010 < 0.05 and in the control class 0.003 < 0.05. Based on Shapiro Wilk's normality hypothesis, H0 is rejected and Ha is accepted, so the data obtained from learning outcomes after treatment is not normally distributed. Meanwhile, the physics knowledge of experimental class students is 0.004 < 0.005 and control class is 0.038 < 0.005. The normality hypothesis H0 is rejected and Ha is accepted and the data is not normally distributed.

The homogeneity test was carried out with the aim of finding out whether there was a difference in variance between the two classes or not after being given treatment.

Table 2. Homogeneity test

Variables	F	df1	df2	Sig.
Creativity	4,531	1	58	0,038
Physics knowledge	5,362	1	58	0,019

Based on 2 Levene's test results, it shows that the significance value of each variable is 0.038 and 0.019, which is smaller than 0.05. Based on this, it was decided that Ho was rejected so that it could be concluded that the variance matrix for each variable after receiving differentiated and conventional learning was not homogeneous.

The correlation test aims to determine whether or not there is a relationship between creativity and physics knowledge in the experimental class with differentiated learning and the control class with conventional learning.

Table 3. Correlation of creativity and knowledge in the experimental class

		Creativity	knowledge
Creativity	N	30	30
	Pearson Correlation	1	0,252
	Sig. (2-tailed)		0,179
Physics knowledge	N	30	30
	Pearson Correlation	0,252	1
	Sig. (2-tailed)	0,179	

Table 4. Correlation of creativity and knowledge in the control class

		Creativity	knowledge
Creativity	N	30	30
	Pearson Correlation	1	-0,150
	Sig. (2-tailed)		0,430
Physics knowledge	N	30	30
	Pearson Correlation	-0,150	1
	Sig. (2-tailed)	0,430	

Based on Table 3 of the experimental class, the correlation between creativity and knowledge, the significance value is 0.179 > 0.05 and the pearson degree relationship is 0.252, so it can be concluded that creativity and knowledge have no correlation. Likewise, in Table 4, for the control class, the significance value is 0.430 > 0.05 and the degree of person correlation is -0.150, there is also no correlation.

Hypothesis Test

Used on the grounds that this research is non-parametric research. Wilcoxon is used to compare and see differences between pretest data. The Wilcoxon test is used because there is data that is not normally distributed, so Wilcoxon and posttest data. The criteria for changes to

occur are if the Asymp value. Sig (2-tailed) ≤ 0.05 and if the Asymp. Sig (2-tailed) ≥ 0.05 does not change after learning treatment.

Table 5. Results of the Wilcoxon creativity test for the experimental class

	Experimental class creativity posttest-pretest
Z	-4,791[b]
Asymp. Sig (2-tailed)	0.000

The Wilcoxon test statistics test for creativity in the experimental class shows that the Z count is -4.79b and the sig is 0.000 <0.05. It can be concluded that there is a change in creativity learning outcomes in the class after being given differentiated learning.

Table 6. Results of the Wilcoxon test of experimental class knowledge

	Posttest-preetest experimental class knowledge
Z	-4,805[b]
Asymp. Sig (2-tailed)	0,000

The experimental class creativity statistics show that the calculated Z is -4.805b and the sig is 0.000. It can be concluded that there is a change in learning outcomes for physics knowledge in the experimental class after being given differentiated learning.

Table 7. Results of the Wilcoxon creativity test for the control class

	Posttest-preetest control class creativity
Z	-2,757[b]
Asymp. Sig (2-tailed)	0,006

The Wilcoxon test statistics for control class creativity show that the Z count is -2.757 and the sig is 0.006 > 0.05 (5% error rate). So it was concluded that there was no difference in creativity in the control class before and after learning.

Table 8. Results of the Wilcoxon test of control class knowledge

	Posttest-preetest control class knowledge
Z	-4,267
Asymp. Sig (2-tailed)	0,000

Control class knowledge shows that Z count is -4.267 and sig is 0.000. It can be concluded that there is a change in physics knowledge learning outcomes in the control class after being given conventional learning without distinguishing between student characteristics.

The independent sample test used is the Mann Whitney test or U test. The aim of the researcher using the Mann Whitney Test is to determine whether there is a difference in the averages of two unpaired samples and also because in this study the data obtained is not normally distributed and is not homogeneous. The criteria are that Ha is accepted and Ho is rejected if the significance value is ≤ 0.05, while Ho is accepted. Ha is rejected if the significance value is ≥ 0.05.

Table 9. Posttest differences in creativity between the experimental class and the control class

	Posttest kreativitas
Mann-Whitney U	14,000
Wilcoxon W	479,000
Z	-6,490

Asymp.Sig (2-tailed)	0,000

Based on Table 9, the significance value is 0.000 ≤ 0.05, it can be concluded that there is a difference in creativity learning outcomes after learning between the experimental class which uses differentiated learning and the control class which does not receive conventional learning or treatment. From this analysis, differentiated learning has a good influence and effectiveness on SMAN 4 PPU students.

Table 10. Posttest differences in knowledge of the experimental class and control class

	Knowledge posttest
Mann-Whitney U	113,000
Wilcoxon W	578,000
Z	-5,046
Asymp.Sig (2-tailed)	0,000

If the significance value is 0.000 ≤ 0.05, it can be concluded that there is a difference in learning outcomes for physics knowledge after learning between the experimental class which uses differentiated learning and the control class which does not receive differentiated learning or treatment. From this analysis, differentiated learning has a good influence and effectiveness on SMAN 4 PPU students.

Discussion

This research was conducted to determine the effect of the differentiated learning model on students' creativity and physics knowledge, whether there is a significant difference between the creativity learning outcomes and physics knowledge of students who use the differentiated learning model and those who use conventional learning or lectures and what is the effectiveness of differentiated learning in the independent curriculum in improving students' creativity and physics knowledge on energy content. The research used two classes, namely the experimental class which used a differentiated learning model and the control class which used conventional methods.

This research began or at the first meeting by conducting a pretest in both the experimental class and the control class. After that the researcher carried out a second test, namely a diagnostic test, but this test was carried out only in the experimental class via the link https://akupintar.id/tes -learning styles, where in this test the students' characteristics are looked at and grouped according to their learning style, where there are 16 students with a visual learning style, 5 students with an audio learning style and 9 students with a kinesthetic style. Meanwhile, in the control class, researchers did not carry out diagnostic tests but continued with conventional learning.

Based on the results of the description using Excel, non-parametric statistics using SPSS, the pretest, posttest and learning process data, where the average value of the control class before learning was 72.13 and after learning was 73.60 and for knowledge it was 42.33 to 58. 00, this shows a slight increase in the average score before and after learning, but this increase does not look good. Meanwhile, in the experimental class, students showed creativity before the learning process of 72.200 and experienced an increase in the learning process by paying attention to the characteristics of the students to 85.37 and in their knowledge learning outcomes from 41.33 to 82.57.

The results of differentiated learning have a very good influence, so with good learning and paying attention to the characteristics of students, increased creativity in learning will influence each other with their knowledge. There was an increase in the posttest score compared to the pretest, both in creativity and formative, the increase in the learning process in the experimental

class was very good. Meanwhile, the control class also experienced an increase, but the expected increase was not as good as in the experimental class. The results of the hypothesis test show that there is a difference in the average of the class that uses the differentiated model and the class that uses the conventional method in terms of creativity and knowledge. This can be seen from the average of creativity and knowledge in the class that uses the differentiated model which is better than the average of the class that uses the conventional method.

Based on the results of descriptive statistics, it can be concluded that there is a significant influence of the differentiated learning model in increasing students' creativity and physics knowledge on energy content compared to using conventional learning models or lectures. This is reinforced by previous research findings which state that differentiated learning is a series of common sense decisions made by teachers that are oriented towards student needs (Kusuma & Luthfah, 2020). Differentiated learning provides space for initiative, creativity and independence according to talents, interests and physical and psychological development (Marlina, et al., 2019).

Creativity is the process of contributing ideas or concepts in solving a problem faced in a fun way and feeling challenged by the problem (Lestari & Zakiah, 2019). Creativity in this case is a thinking process, namely students trying to get answers to new methods or ways of solving problems. One way to increase students' learning motivation is with a differentiated model, because good learning is student-centered learning where teachers need to pay attention to students' readiness to accept the material being taught, the characteristics, interests and talents of students..

Conclusion

Differentiated learning is an action carried out by teachers in the classroom that adapts the learning process to the needs of each student, so that the needs of each child can be met as a whole, because learning is linked to students' interests, learning profiles and readiness so as to achieve increased student learning creativity. The use of differentiated learning models has a more significant effect on increasing students' creativity and physics knowledge learning outcomes compared to the use of conventional learning models.

Researchers recommend that the use of differentiated learning models can be applied at all levels of education, especially in subjects that are considered difficult for students.

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