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IMPLEMENTATION OF CONTEXTUAL-BASED DIFFERENTIATIONAL LEARNING ON THE PROBLEM-SOLVING ABILITY OF GRADE 8^{TH} STUDENTS

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Abstract

Problem-solving ability is one of the important skills in learning mathematics because it involves high-level thinking processes needed to solve complex and contextual problems. However, in reality, many students still have difficulty in understanding and solving mathematical problems because learning does not adjust to individual needs. Therefore, differentiated learning is a relevant approach because it is able to accommodate the diversity of learning styles, interests, and student readiness. This study aims to describe the application of contextual-based differentiated learning to the problem-solving abilities of grade VIII students. This study is a quantitative study with a quasi-experimental method. The research design used is a pretest-posttest control group design. Data collection techniques use observations of teachers' ability to manage learning, observations of student activities and problem-solving ability tests before and after learning. The results of the study showed that the results of observations of teachers managing learning were good because the average score was 3.00, the results of observations of student activities were 3.49, the completeness of learning outcomes in the experimental class had met the minimum completeness criteria (KKM) and the problem-solving abilities of students taught with contextual-based differentiated learning were better than the problem-solving abilities of students taught with conventional learning because the t-test showed a significant difference between the experimental and control classes (sig.0.011 <0.05), while the n-gain test showed a higher increase in problem-solving abilities in the experimental class (78.97%) compared to the control class (77.53%). This shows that contextual-based differentiated learning is more effective than conventional learning.

Keywords: *differentiated learning, contextual approach, problem solving skills*

Abstrak

Kemampuan pemecahan masalah merupakan salah satu keterampilan penting dalam pembelajaran matematika karena melibatkan proses berpikir tingkat tinggi yang dibutuhkan untuk menyelesaikan persoalan kompleks dan kontekstual. Namun, kenyataannya banyak siswa yang masih mengalami kesulitan dalam memahami dan menyelesaikan masalah matematika karena pembelajaran yang tidak menyesuaikan kebutuhan individu. Untuk itu, pembelajaran berdiferensiasi menjadi pendekatan yang relevan karena mampu mengakomodasi keberagaman gaya belajar, minat, dan kesiapan siswa. Penelitian ini bertujuan untuk mendeskripsikan penerapan pembelajaran berdiferensiasi berbasis kontekstual terhadapan kemampuan pemecahan masalah siswa kelas VIII. Penelitian ini merupakan penelitian kuantitatif dengan metode *quasi eksperimen.* Desain penelitian ini yang digunakan adalah *pretest-posttest control group design*. Teknik pengumpulan data menggunakan observasi kemampuan guru mengelola pembelajaran, observasi aktivitas siswa dan tes kemampuan pemecahan masalah sebelum dan sesudah pembelajaran. Hasil penelitian menunjukkan bahwa hasil observasi guru mengelola pembelajaran baik karena skor rata-rata 3.00, hasil observasi aktivitas siswa 3.49, ketuntasan hasil belajar pada kelas eksperimen telah memenuhi kriteria ketuntasan minimal (KKM) dan kemampuan pemecahan masalah siswa yang diajar dengan pembelajaran berdiferensiasi berbasis kontekstual lebih baik daripada kemampuan pemecahan masalah siswa yang diajar dengan pembelajaran konvensional karena uji-t menunjukkan perbedaan signifikan antara kelas eksperimen dan control $(\text{sig.}\,0.011 < 0.05)$, sedangkan uji n-gain menunjukkan peningkatan kemampuan pemecahan masalah yang lebih tinggi pada kelas eksperimen $(78{,}97\%)$ dibandingkan kelas kontrol $(77{,}53\%)$. Hal ini menunjukkan bahwa pembelajaran berdiferensiasi berbasis kontekstual lebih efektif dibandingkan pembelajaran konvensional.

Kata kunci: pembelajaran berdiferensiasi, pendekatan konstektual, kemampuan pemecahan masalah

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INTRODUCTION

Mathematics is a tool for developing logical, critical, and systematic thinking patterns. As a basic science, both its applied and logical aspects support the advancement of technology and science (Siagian, 2016). To understand mathematics, students must understand the mathematical concepts that are the basis for understanding certain topics to solve the problems faced.

However, in reality, mathematics learning is less popular with students because it is considered difficult and hard. Agustina (2016) stated that mathematics learning is a learning that is avoided by students because of the difficulty in understanding the material. It is not surprising that students' mathematics learning outcomes are less than optimal.

The mathematical abilities that students need to have are not limited to the ability to count, but also the ability to solve mathematical problems, mathematical connections, mathematical reasoning, communication, and student representation (Zuhri & Purwosetiyono, 2019). Among these abilities, problem solving is also a basic ability as well as a goal of mathematics learning (Safitri, Yasintasari, Putri, & Hasanah, 2020). Students are expected to have good problem-solving skills in mathematics learning so that they can become quality human resources (Yuwono, Supanggih, & Ferdiani, 2018).

Harahap & Surya (2017) stated that mathematical problem solving ability is a complex cognitive activity and requires the right strategy. According to Polya (Hendriana et al., 2017) problem solving ability can be measured using indicators, namely: (1) understanding the problem; (2) planning a solution (devising a plan); (3) carrying out the problem solving process according to the plan that has been prepared (carrying out the plan); (4) re-examining the results that have been obtained (looking back).

Each student has uniqueness and diversity inherent in each of them, both in terms of learning style, interests, learning readiness, and socioeconomic status/SSE (Wulandari, 2022). Therefore, a learning approach is needed that can accommodate this diversity. One relevant approach is differentiated learning. Marlina (2019), states that differentiated learning is an approach that adjusts content, processes, products, and learning environments to suit students' needs. In this study, researchers applied it in terms of content, namely by adjusting teaching materials and LKPD based on students' problem-solving abilities (Irdhina et al., 2021).

Contextual problem-based learning is very good when applied in the learning process. This is because problems in learning are associated with facts or events in real life, making it easier for students to understand the learning material presented. According to Aqib (2016), contextual problem-based learning (Contextual Teaching and Learning/CTL) is an approach that helps teachers relate learning materials to students' real-world situations. This approach encourages students to apply the knowledge they have learned in everyday life. In this learning model, students not only learn concepts theoretically, but are also given the opportunity to connect the material with the experiences and challenges they face in the real world. Thus, contextual problem-based learning provides a more meaningful experience for students and improves their problem-solving skills, because the material taught is relevant to the context of their lives.

According to Sajaya & Setiyowati (2019), contextual-based learning includes seven components, namely constructivism, discovery, asking, learning communities, modeling, reflection, and authentic assessment.

Based on this background, this study aims to describe the application of contextual-based differentiated learning to the problem-solving abilities of grade VIII students. In addition, this study also aims to determine whether the problem solving of students taught with contextual-based differentiated learning models is better than the learning outcomes of students taught with conventional learning.

METHODS

This research is a quantitative research with a quasi-experimental method. The research design used is pretest-posttest control group design, where there are two groups to be studied, namely the experimental group and the control group. The experimental group will be given treatment in the form of contextual-based differentiated learning, while the control group will receive conventional learning.

The population in this study was class 8^{th} at SMP Negeri 1 Tragah, located at Jl. Raya Tragah, Tragah District, Bangkalan Regency, East Java 69165. Where for class 8^{th} consists of two classes, namely class 8 C and 8 D. According to Sugiyono (2016) purposive sampling is a sample determination technique with certain considerations. The sample in this study was class 8 C with 26 students as an experimental class that was given treatment in the form of contextual-based differentiated learning. Then for class 8 D is a control class with 26 students who will receive conventional learning. In general, the research design can be described as follows:

Table 1. Pretest-Posttest Control Group Design Form

Class	Pretest	Treatment	Posttest
C	C_1	X_1	C_2
D	D_1	X_2	C_2

Before being given treatment, both groups were given a pretest with the same material first to determine initial knowledge, then continued with the provision of treatment (X_1 and X_2) in each class. The experimental class was given contextual-based differentiated learning treatment (X_1) while the control class was given conventional learning treatment (X_2). After being given each treatment, a posttest was given to each class.

As for data collection, it uses observation and test techniques (pretest and posttest). The research instruments used are observation sheets of teacher ability to manage learning, observation sheets of student activities, pretest, posttest. Learning tools in the form of learning modules. Before using the research instrument. First, validation is carried out by expert validators consisting of 1 mathematics lecturer and 1 mathematics teacher. By using the validation sheet, the three instruments are said to be valid if they meet certain competencies seen from the indicators to be achieved.

Data analysis was conducted using two types of analysis, namely descriptive statistical analysis and inferential statistical analysis. As for descriptive statistical analysis, namely:

1. **Analysis of teacher ability in managing learning**

   Descriptive statistical analysis applied according to (Lasmi, 2017) is using the average score.

$$\text{Average score} = \frac{\text{Average score}}{\text{number of observation aspects}}$$

   The average score categories are as follows:

   1.00 ≤TKG<1.50 : very bad

   1.50 ≤TKG<2.50 : bad

   2.50 ≤TKG<3.50 : good

   3.50 ≤TKG<4.00 : very good

2. Student activity analysis

Student activities were analyzed using averages. The categories of average student activity scores can be seen in Table 2.

Table 2. Analysis of student activities

Point Biserial Correlation	Information
$3{,}50 \leq \text{SAS} \leq 4{,}00$	Very Active
$2{,}50 \leq \text{SAS} \leq 3{,}50$	Active
$1{,}50 \leq \text{SAS} \leq 2{,}50$	Less Active
$1{,}00 \leq \text{SAS} \leq 1{,}50$	Not Active

3. Analysis of learning outcomes completion

The criteria for a student to be considered complete is if they meet the Minimum Completion Criteria (KKM), namely 75.

Table 3. Analysis of learning outcome completion

Mastery Level	Categorization of Learning Completion
$0 \leq x < 75$	Incomplete
$75 \leq x \leq 100$	Complete

Furthermore, classical student completion is achieved if many students complete their studies $\geq 80\%$.

Next, in the inferential analysis, namely to determine whether there is a significant difference in problem-solving ability between the experimental group and the control group, there are 4 stages of testing carried out, namely first, a normality test is carried out before the t-test is carried out which aims to determine the normality of the data obtained from the pretest and posttest values. Second, a homogeneity test is carried out to test the similarity of variance. Third, the hypothesis test uses a t-test to measure the difference in problem-solving ability after being taught contextual-based differentiation learning and conventional learning. Furthermore, the fourth test is the N-gain test to assess the increase in problem-solving ability after being taught contextual-based differentiation learning and conventional learning.

If the results of the normality test using Shapiro-Wilk show that the sig value ≥ 0.05, then the data is declared normally distributed. Then in the homogeneity test if the sig rate is obtained ≥ 0.05 so that it can be stated that the data is homogeneous. Furthermore, conducting a hypothesis test using the t test, If the significance (P) ≥ 0.05 then H_0 is accepted. Conversely, if the significance (P) < 0.05 then H_0 is rejected. The following are the statements of H_0 and H_1.

a. H_0: $\mu_1 = \mu_2$ there is no difference between the problem-solving abilities of grade VIII students after being taught with contextual-based differentiation learning and the problem-solving abilities of grade VIII students after being taught with conventional learning.
b. H_1: $\mu_1 \neq \mu_2$ there is a difference between the problem-solving abilities of grade VIII students after being taught with contextual-based differentiation learning and the problem-solving abilities of grade VIII students after being taught with conventional learning.

The last test is the N-gain test. The N-gain test is an analysis technique used to assess the improvement of students' ability to solve mathematical problems after being given a certain treatment. This test calculates the difference between students' pretest and posttest scores, which provides an overview of how effective a learning method is in improving students' understanding.

RESULTS AND DISCUSSION

This research produced data in the form of observation results of teachers' ability to manage learning, observation results of student activities, student learning outcomes in the experimental class, as well as the results of inferential statistical analysis to determine the differences between the experimental class and the control class.

1. Observation data on teachers' ability to manage learning

The results of observations of teachers' ability to manage learning are presented in Table 4.

Table 4. Recapitulation of Teachers' Ability to Manage Learning Models

No	Observed Aspects	Evaluation			
		1	2	3	4
1.	Implementation Aspects				
	Introduction				
	a. Conduct an opening with an opening greeting and prayer to			3	

	start the learning process.	
	b. Checking student attendance as a form of discipline	3
	c. The teacher asks about the previous meeting's material	3
	d. Explains the things that will be learned, the competencies to be achieved, and the learning methods that will be used.	3
	e. The teacher invites students to do ice breaking	3
	f. The teacher conveys the benefits of studying the material being studied	3
2.	Core activities	
	• Before students discuss, the teacher starts asking questions using trigger questions • The teacher gives all students the opportunity to answer questions from the teacher.	3 3
	• The teacher gives appreciation to all students who dare to answer and continue to ask provocative questions. The teacher forms students into 3 groups according to the mapping results, namely group A, group B, and group C.	3
	• The teacher explains the concept of exponents. Then the teacher gives LKPD to students with questions and problems that are appropriate to the level of student readiness. (Content differentiation)	3
	• Students work in pairs or small groups to understand and discuss the concept of exponents and their properties. Then students are able to complete operations on exponents. (Process differentiation)	3

	• The teacher then gives students the opportunity to present their findings based on their understanding using a format of their own choosing. (Product Differentiation)	3
	• The teacher appreciates the students' answers and gives another opportunity if there are different answers.	3
	• The teacher closes the student discussion by providing reinforcement to the students' answers that have been presented.	3
3.	Closing	
	a. Summarize the activities that have been carried out	3
	b. Inform the learning activity plan for the next meeting.	3
	c. The teacher closes the lesson with a prayer and closing greeting.	3
4.	Time use	3
5.	Classroom conditions during learning	3
	Amount	51
	Average	3,00

Based on the observation results, the average value of teachers' ability in managing learning was 3.00, which is included in the good category. This shows that teachers are able to implement contextual-based differentiated learning effectively. The activities carried out, such as providing LKPD that is adjusted to student readiness (content differentiation), discussing exponential material in small groups (process differentiation), and providing choices in how students transmit their learning outcomes (product differentiation), have been implemented well to support student understanding.

2. Student activity data

The results of student activity data can be seen in Table 5.

Table 5. Recapitulation of student activities

No	Group	Student	Observed aspects	Amount	Qualification

		Name	A				B				C				D				E					
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4		
1.	Tall	MS			3				3				3				3				3		15	3
		IS			3				3				3				3				3		15	3
		VA			3				3				3				3				3		15	3
		RA			3				3				3				3				3		15	3
		WM			3				3				3				3				3		15	3
		SS			3				3				3				3				3		15	3
2.	Currently	ZH			3				3				3				3				3		15	3
		FW			3				3				3				3				3		15	3
		IH			3				3				3				3				3		15	3
		TI			3				3				3				3				3		15	3
		FN			3				3				3				3				3		15	3
		IA			3				3				3				3				3		15	3
		MI			3				3				3				3				3		15	3
3.	Low	MS		2				2				2				2				2			10	2
		AW		2				2				2				2				2			10	2
		IH		2				2				2				2				2			10	2
		AS		2				2				2				2				2			10	2
		DP		2				2				2				2				2			10	2
		RF		2				2				2				2				2			10	2
		ZA		2				2				2				2				2			10	2
		BS		2				2				2				2				2			10	2
																							275	55
																							3,49	

Based on Table 5, the aspects observed include: (A) pays attention to the delivery of material by the teacher, (B) collaborates with friends in groups, aspect (C) fluency in presentation, (D) speed and accuracy in answering questions, and aspect E irrelevant student assessment. The results of the analysis show that the average student activity score reached 3.49, which is included in the active category.

This reflects that a learning approach that accommodates differences in student readiness through different activities is able to encourage active participation in the learning process.

3. Completeness of learning outcomes in the experimental class

The results of data completeness in the experimental class can be seen in Table 6.

Table 6. Student Scores After Being Taught Contextual-Based Differentiated Learning

No	Nama	Nilai	Keterangan
1	MF	84	Complete
2	MI	84	Complete

3	IA	84	Complete
4	ZA	83	Complete
5	IS	93	Complete
6	IH	86	Complete
7	TI	88	Complete
8	SR	86	Complete
9	AF	81	Complete
10	SI	84	Complete
11	RA	83	Complete
12	SF	84	Complete
13	MS	88	Complete
14	VA	92	Complete
15	RA	86	Complete
16	AW	83	Complete
17	FN	88	Complete
18	FA	86	Complete
19	ZH	88	Complete
20	FM	86	Complete
21	WM	88	Complete

Based on the analysis of the results of the experimental class data completion from 21 students, it met the minimum completion criteria (KKM) so that 100% of students completed learning after being taught using contextual-based differentiated learning.

Inferential analysis was conducted to determine whether there was a difference between the problem-solving abilities of students taught with contextual-based differentiated learning and conventional learning. Data on students' pretest and posttest results were obtained from student learning outcomes before and after the application of the learning model in two groups, namely the experimental class implementing contextual-based differentiated learning and the control class using conventional learning. The average pretest and posttest scores are presented in Table 7.

Class	Pretest average	Posttest average
Experiment	30,71	85,95
Control	20,04	83,61

Based on the pretest analysis before the implementation, the two classes obtained were still below the minimum completion criteria (KKM), after the implementation of the posttest, the two classes obtained a passing score.

Learning Outcomes

1. **Normality test**

The data from the normality test results obtained from the pretest and posttest of both classes are presented in Table 8.

Table 8. Normality test of experimental class and control class

Tests of Normality

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Student Learning Outcomes	Differentiated Learning Experiment Pretest	.181	21	.072	.894	21	.027
	Posttest Differentiated Learning Experiment	.173	21	.102	.918	21	.081
	Conventional Learning Control Pretest	.224	21	.007	.843	21	.003
	Posttest Conventional Learning Control	.152	21	.200*	.901	21	.037

Based on the data results in the table above, only the experimental class posttest data has a significance value of 0.081 (≥ 0.05), so it is normally distributed. Other data are not normally distributed. However, further statistical analysis can still be continued because the sample size is adequate and the data is homogeneous.

2. **Homogeneity test**

The homogeneity test data obtained in both posttest classes can be presented in Table 9.

Table 9. Homogeneity test of experimental class and control class

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Student Learning Outcomes	Based on Mean	.033	1	40	.857
	Based on Median	.069	1	40	.794
	Based on Median and with adjusted df	.069	1	38.980	.794
	Based on trimmed mean	.042	1	40	.839

Based on the data results in the table above, the sig value of the posttest of the control and experimental classes based on mean is 0.857, because the sig value of 0.857> 0.05, thus it can be said that both data have homogeneous variance.

3. Hypothesis Test

Hypothesis test data was conducted using an independent t-test (Independent Samples T-Test). The data used were the posttest results of both classes which can be presented in Table 10.

Table 10. Hypothesis testing of experimental and control classes

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	T	Df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Student Learning Outcomes	Equal variances assumed	.033	.857	-2.682	40	.005	.011	-2.333	.870	-4.092	-.575
	Equal variances not assumed			-2.682	39.494	.005	.011	-2.333	.870	-4.092	-.574

From the data results obtained sig. value (2-tailed) of 0.011 where $0.011 < 0.05$ so that based on the significance H_0 is rejected. Thus based on the hypothesis testing criteria it can be concluded that there is a significant difference in the learning outcomes of students in the experimental class and control class.

4. N-gain test

The n-gain test data were obtained from the pretest-posttest data of students in both classes. The gain test was used to determine the effectiveness of the differentiated learning model and the conventional learning model presented in Table 11.

Table 11. N-Gain test of experimental class and control class

Descriptives

	Group			Statistic	Std. Error
N_GainPersents	Experiment	Mean		78.9770	1.16417
		95% Confidence Interval for Mean	Lower Bound	76.5486	
			Upper Bound	81.4055	
		5% Trimmed Mean		79.3100	
		Median		80.2326	
		Variance		28.461	
		Std. Deviation		5.33492	
		Minimum		65.22	
		Maximum		86.67	
		Range		21.45	
		Interquartile Range		5.42	
		Skewness		-1.208	.501
		Kurtosis		1.200	.972
	Control	Mean		77.5301	.59275
		95% Confidence Interval for Mean	Lower Bound	76.2936	
			Upper Bound	78.7666	
		5% Trimmed Mean		77.5364	
		Median		76.7442	
		Variance		7.379	
		Std. Deviation		2.71634	
		Minimum		72.00	
		Maximum		82.93	
		Range		10.93	
		Interquartile Range		3.70	
		Skewness		.096	.501
		Kurtosis		-.121	.972

Based on the results of the gain test calculation, it shows that the average value of the gain test for the experimental class (differentiated learning model) is 78% with a maximum and minimum percentage of 86% and 65%. While the average value of the gain test for the control class (conventional learning model) is 77% with a maximum and minimum percentage of 82% and 72%. Based on the interpretation of the effectiveness of the gain test, we can conclude that the use of a differentiated learning model is more effective for students' problem-solving abilities in the material of grade VIII exponents than the Conventional learning model. This can be seen from the minimum and maximum averages.

DISCUSSION

Based on the results of the study above, it was found that the application of contextual-based differentiated learning has proven effective in improving the mathematical problem-solving abilities of grade VIII students. This can be seen from several important aspects. First, the teacher's ability to manage learning showed good results with an average score of 3.00, which indicates that the teacher is able to apply this approach systematically. Second, student activities during the learning process were also classified as active, with an average score of 3.49. Students were actively involved in group discussions and were able to complete assignments that were adjusted to their learning styles and levels of readiness. Third, all students in the experimental class achieved learning completion with an average posttest score of 85.95, which indicates that differentiated learning was able to improve students' understanding of the material on exponents. Fourth, the results of the hypothesis test showed a significant difference between the experimental class and the control class, with a significance value of $0.011 < 0.05$. In addition, the results of the N-gain test showed a higher increase in problem-solving abilities in the experimental class (78.97%) compared to control class (77.53%).

This finding is in line with the results of previous studies by Marlina (2019), Apriyantini et al. (2023), and Rohim et al. (2024), which stated that a differentiated approach increases activeness, conceptual understanding, and problem-solving abilities. However, this study has a new contribution because it combines three aspects of differentiation at once content, process, and product which are tailored to student readiness and linked to real contexts in the exponent material. This makes learning more meaningful and encourages students to think critically. In other words, contextually differentiated learning is not only effective in terms of learning outcomes, but can also strengthen high-level thinking skills that are very important in learning mathematics.

Contextualization of the material is done by exposing the exponents to real-world phenomena, such as bacterial growth and radioactive decay, to help students understand the concepts with relevant applications. Therefore, contextual-based differentiation learning can be applied as an alternative to improve the quality of student learning outcomes in mathematics.

Therefore, it can be concluded that contextual-based differentiated learning is feasible to be applied as an alternative in mathematics learning to improve the quality of student learning outcomes.

CONCLUSION

1. Based on the research conducted, it can be concluded that there are significant differences in the learning outcomes of students taught using differentiated and conventional learning models on the material of ordinal numbers.
2. The research results obtained show that the differentiated learning model is more effective for use with class VIII students with an average of 78% compared to the conventional learning model with an average of 77%.

ACKNOWLEDGMENTS

This research can be a valuable input for the world of education, especially for teachers, to apply contextual-based differentiated learning in developing students' problem-solving abilities. For further researchers, it is expected to conduct research by combining this differentiated learning approach with other strategies, techniques, or methods to further assist students in learning mathematics. The writing of the research cannot be separated from the support, guidance, and cooperation of various parties. Therefore, the researcher would like to express his deepest gratitude to all parties who have provided support and assistance in completing this research.

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