Effectiveness of Differentiation Learning Strategies in Mathematics Learning at Junior High School

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Article History:
Received: Nov 30, 2022
Revised: Dec 27, 2022
Accepted: Jan 09, 2023
Online First: Jan 10, 2023

Keywords:
Effectiveness of Learning, Differentiated learning, Learning Strategies in Math.

Kata Kunci:
Efektivitas Pembelajaran, Pembelajaran Differensiasi, Strategi belajar matematika.

How to cite:
Simanjuntak, S. D., Tinambunan, R., Imelda, I., Sembiring, R. K., & Sitepu, I. (2023). Effectiveness of Differentiation Learning Strategies in Mathematics Learning at Junior High School. *Edunesia: Jurnal Ilmiah Pendidikan, 4*(1), 247-258.

Abstract: This study aimed to determine whether differentiation learning in junior high school mathematics learning was practical. The method used in this study is a quasi-experimental research design with Pretest-Posttest Control Group Design. The population in this study were all eighth graders of St Yoseph Private Junior High School Medan, which consisted of five classes with 32 people in each class. The sample in this study was 64 students consisting of 32 students for the experimental class and 32 for the control class. The results showed that the average student activity in content differentiation was 2.33 in the excellent category, the application of process differentiation was 2.33 in the excellent category, and the application of product differentiation was in a suitable category. The average value of teachers' ability to implement content differentiation is 3 in the excellent category, the average value in the implementation of process differentiation is 2.25 in the excellent category, and the implementation of product differentiation is 2.75 in the excellent category. Based on the results of research and hypothesis testing that has been carried out, the differentiation learning process runs effectively, which can improve students' mathematical abilities. This can be seen from the difference in the average post-test score of students in the experimental class and control class of 2.25%, the percentage of students who meet the KKM is 62.5%, the average student activity is 76.6%, and also the average level of teacher ability in managing differentiation learning in the experimental class is 89%. This research implies that differentiation learning is effectively used for junior high school mathematics learning.

Abstrak: Tujuan penelitian ini adalah untuk mengetahui apakah pembelajaran diferensiasi dalam pembelajaran matematika SMP efektif. Penelitian ini dilaksanakan di SMP Swasta St. Yoseph Medan tahun ajaran 2021/2022. Metode yang digunakan dalam penelitian ini adalah eksperimen semu dengan desain penelitian Pretest-Posttest Control Group Design. Populasi dalam penelitian ini adalah seluruh kelas VIII SMP Swasta St. Yoseph Medan yang terdiri dari lima kelas dengan masing-masing kelas berjumlah 32 orang. Sampel dalam penelitian ini adalah 64 siswa yang terdiri dari 32 siswa untuk kelas eksperimen dan 32 siswa untuk kelas kontrol. Hasil penelitian menunjukkan bahwa rata-rata aktivitas siswa pada penerapan diferensiasi konten adalah 2,33 dalam kategori baik, penerapan diferensiasi proses 2,33 dalam kategori baik dan juga penerapan diferensiasi produk termasuk dalam kategori baik. Nilai rata-rata kemampuan guru dalam penerapan diferensiasi isi adalah 3 dengan kategori sangat baik, nilai rata-rata penerapan diferensiasi proses 2,25 dengan kategori baik dan penerapan diferensiasi produk 2,75 termasuk dalam kategori baik. Berdasarkan hasil penelitian dan pengujian hipotesis yang telah dilakukan, dapat disimpulkan bahwa proses pembelajaran diferensiasi berjalan efektif yang dapat meningkatkan kemampuan matematika siswa. Hal ini terlihat dari perbedaan rata-rata nilai posttest siswa pada kelas eksperimen dan kelas kontrol sebesar 2,25%, persentase siswa yang memenuhi KKM sebesar 62,5%, rata-rata aktivitas siswa sebesar 76,6% dan juga rata-rata level guru. kemampuan mengelola pembedaan pembelajaran pada kelas eksperimen yaitu sebesar 89%. Implikasi dari penelitian ini adalah pembelajaran diferensiasi efektif untuk pembelajaran matematika SMP.

https://doi.org/10.51276/edu.v4i1.310

A. Introduction

According to Sukmadinata (in Tarigan, 2020), "Education is an effort to educate the nation's life, shape personality, cultivate moral and religious values, train good skills, teach knowledge, provide guidance, direction, and form skills". Many years ago until now, education in Indonesia has mostly stayed the same, where it still implements the old learning system that considers all children to be the same, more teacher-centered, without or rarely providing opportunities for each student to participate in learning actively.

Students often sit quietly, listening to what the teacher explains without doing anything that could add to their learning experience. In the classroom, there are approximately 30-40 students with different, unique, diverse, and learning experience abilities, but the teacher seems only to teach one student in one class. It is common for children to feel often frustrated and need more motivation to learn. As stated by Zukhrofi (in Andini, 2016) who revealed that: "Education that is expected to be able to improve the standard of living of the community and the nation is not only a vehicle *for the transfer of knowledge* ". Therefore, educators must be aware that each student is unique and has characteristics that are different from others. In this case, it is necessary to consider when to be given learning in general or specifically. Because according to J. Griful-Freixenet and the team, learning in general and in particular is different (Griful-Freixenet et al., 2021).

Students are figures who have potential. Therefore education must be considered a fertile seedbed to develop students' potential. The learning that will be carried out must allow each student to have the opportunity to expand their potential according to their abilities.

As a facilitator, teachers must recognize students' diversity in a class. The teacher must think about and design a strategy to use in learning. Along with the times, teachers today are required to be creative and innovative in choosing and developing learning methods. Teachers must also be able to meet student's individual needs, the learning environment, and student learning activity (Vantieghem et al., 2020). The goal is for the learning to be effective, meet the learning needs of students, and maximize students' learning potential. Students are said to be successful in learning can be seen from their ability to learn independently, so the learning outcomes obtained are knowledge they have. Therefore, in the learning process, it is necessary to use approaches, strategies, or methods that can foster students' curiosity. One of them is through learning mathematics.

To maximize mathematics learning and improve students' ability to learn mathematics, teachers must be able to distinguish differences in learning instructions in the classroom (Valindes, 2015). Every student has differences in ability, background, interests, learning styles, culture, and readiness to learn (Coubergs et al., 2017). One of the learning strategies that can be used in meeting the learning needs of students who have various abilities is differentiated teaching or differentiating teaching. Another term for Differentiated Teaching is Differentiated Instruction or differentiated Learning, coined by Carol Ann Tomlinson.

https://doi.org/10.51276/edu.v4i1.310

To meet the needs of students, restore or accelerate instruction, and provide learning and growth opportunities for all students, the teacher must be able to become a master of *Differentiated Instruction*. According to Champan and King (in Simanjuntak & Listiani, 2020), differentiated instruction is based on readiness, *learning profile*, and *interest*. Corley (in Lailiyah, 2016) states that differentiated instruction is an approach that allows teachers to plan learning strategies to meet the needs of each learner. According to Adriany (in Lailiyah, 2016), differentiation learning (*Differentiated Instruction*) is a learning theory based on an instructional approach based on differences in individual characteristics in the classroom that respond to the needs of learners.

Based on the explanation above, *differentiation learning (Differentiated Instruction*) is a learning strategy designed by teachers based on student needs, learning interests, learning readiness, and learning styles. The foundation of differentiation learning is active planning, where teachers plan good strategies to meet the needs of students so that students can understand, access, and apply to learn. The formulation of the problem in this study is whether differentiation learning in junior high school mathematics learning is effective. The expected uses of the implementation of this research are: a) Contributing scientific knowledge to expand the world of education. Significantly contributing to improving the quality of learning outcomes, quality of education, and human resources by using differentiation learning, (b) For schools, it is hoped that it can be used as input for consideration in determining mathematical learning to improve student abilities, (c) For students it is expected to be helpful in the learning process, (d) For teachers it is expected to be helpful for the teaching and learning process so that it can provide information to teachers, that the active role of students in the teaching and learning process is essential and provides other alternatives for teachers about learning strategies that can be used in the teaching and learning process and (d) For researchers, it is hoped that they can add insight and knowledge in the implementation of differentiation learning so that later it can be used as material, exercise, and development in carrying out the teaching and learning process.

B. Method

Data analysis in this study was carried out through several stages, namely:

1. Data reduction
   The data obtained is reduced to make it simpler by selecting by grouping these data into several categories and then organizing them so that meaningful information is obtained. The data reduction process is carried out by selecting, simplifying, and transforming the data that has been presented in the form of a table.
2. The clarified data are then presented according to the research problem. Exposure can be done by displaying units of information systematically. With exposure to that information, researchers will conclude easily. The research data is presented in narrative form and equipped with tables and graphs to clarify the analysis.

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3. Concluding (Sugiyono, 2018)

In this activity, several conclusions were drawn based on the research results. The conclusions drawn are the basis for implementing the next cycle and the need for the cycle to continue on the alleged problem.

Before analyzing data, several processes are carried out to obtain data. The steps to obtain data start with the preparation stage, assessing three aspects (student profile, learning readiness, and student interest) and the application stage in class (Marlina, 2019). Graphically such stages of research can be presented in the following figure:

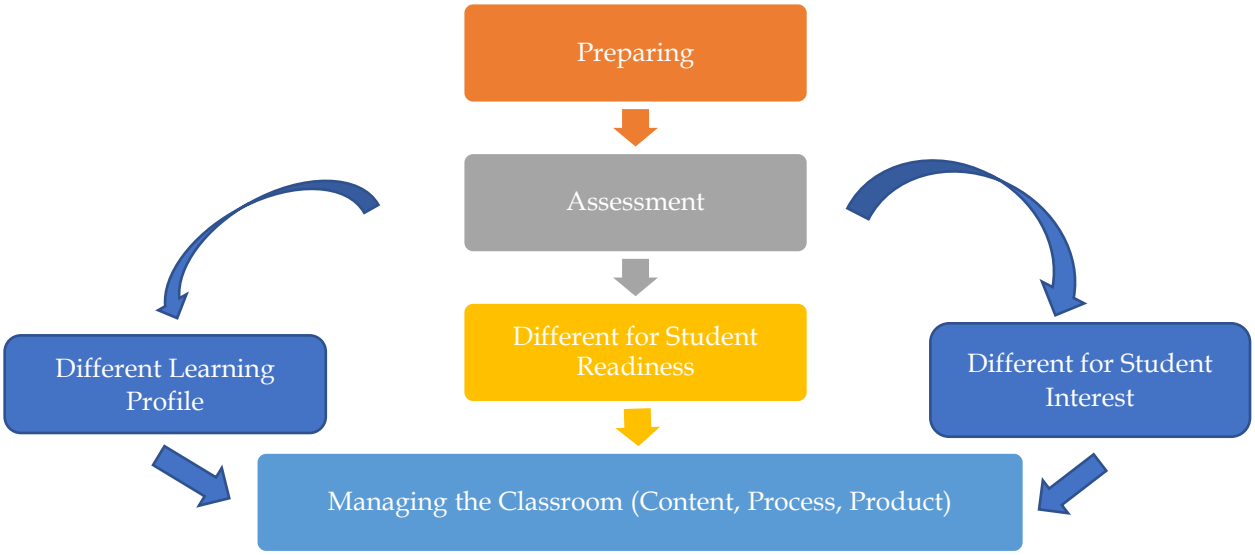

Figure 1. Steps of Differentiated Instruction

Learning effectiveness is the level of success achieved from a particular learning under the planned learning objectives. The effectiveness of differentiation learning in this study can be seen from the test of student learning outcomes, teacher and student activities, and student and teacher responses in learning. All of these aspects are at least in the excellent category.

The data analysis techniques in this study are qualitative and quantitative descriptive analysis. The effectiveness of the learning carried out is measured using the formula:

$$Ep = \frac{\sum_{i=1}^{n} Ep_i}{n}$$

Ep = total mean value for all aspects
Ep *i* = average value for the i-th aspect
n = number of aspects

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Developed learning is said to be effective if the level of effectiveness produced is high. The teacher's ability to manage to learn is obtained using the formula:

$$NKG = \frac{\sum_{i=1}^{m} NK_i}{m}$$

NKG = teacher ability score from category average
Nk_i = i-th category value
m = the number of aspects of the assessment

Teachers are declared capable of learning well if the score obtained by the teacher is good enough.

C. Result and Discussion

The data described in this study are the results of the mathematical ability test of grade VIII students of St. Yoseph Private Junior High School Medan. These results provide information about students' abilities before and after the learning process, both in experimental classes that use differentiation learning approaches and in control classes that use conventional learning approaches. After the data is collected, data analysis is carried out on the mathematical critical thinking ability score data of experimental class students and the mathematical critical thinking ability score of control class students attached. The following is data on the final calculation results of the student's mathematical problem-solving ability test before and after learning is carried out.

Table 1. Description of Pretest and Posttest Thinking Ability Critical Mathematical Students

Value	Experimental Class		Control Class	
	Pretest	**Posttest**	**Pretest**	**Posttest**
N	32	32	32	32
Lowest	28	35	24	32
Highest	76	81	72	79
Average	58,59	67,59	55,28	61,75
St. Deviation	10,21	9,61	12,84	12,07

Source: Research Results (2022)

Based on the calculations in Table 1. above, it can be seen that the number of students in the experimental and control classes is the same, which is 32 students. The lowest pretest score in the experimental class was 28, the highest pretest score in the experimental class was 76, the average pretest score of the students in the experimental class was 58.59, and the standard deviation of the pretest in the experimental class was

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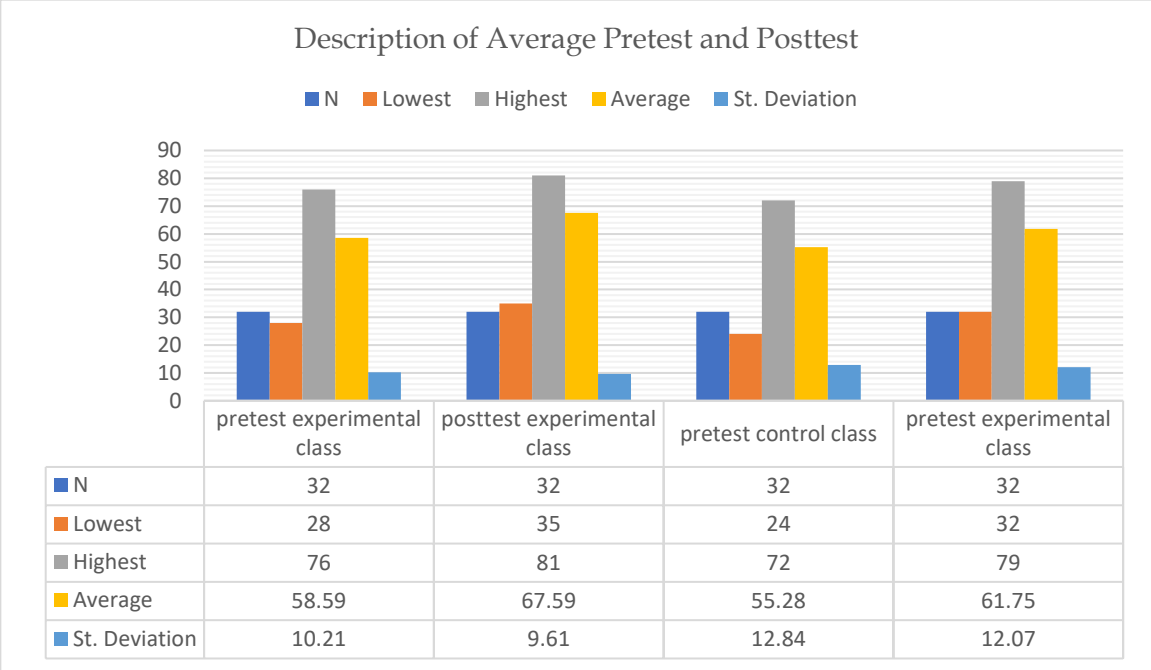
10.21. The lowest pretest score in the control class was 24, the highest pretest score in the control class was 72, the average pretest score of students in the control class was 55.28, and the standard deviation of the pretest in the control class was 12.84.

The lowest post-test score in the experimental class was 35, the highest post-test score in the experimental class was 81, the average post-test score of the students in the experimental class was 67.59, and the post-test standard deviation in the experimental class was 9.61. The lowest post-test score in the control class was 32, the highest post-test score in the control class was 79, the average post-test score of students in the control class was 61.75, and the standard deviation of the post-test in the control class was 12.07.

The description of the pretest and post-test data of the mathematical critical thinking ability of the students of the experimental class and the control class can be seen in the following figure.



	pretest experimental class	posttest experimental class	pretest control class	pretest experimental class
N	32	32	32	32
Lowest	28	35	24	32
Highest	76	81	72	79
Average	58.59	67.59	55.28	61.75
St. Deviation	10.21	9.61	12.84	12.07

Figure 2. Description of Average Pretest and Posttest Students' Mathematical Critical Thinking Ability

Descriptively, several conclusions can be seen from the data obtained from the experimental class and class control seen in table 1, namely:

1. The average score of mathematical critical thinking ability pretests of experimental class students worth, 58.59 was higher than the average score of mathematical critical thinking ability pretests of class control which was 55.28.
2. The average post-test score of the mathematical critical thinking ability of experimental class students, worth 67.59, was higher than the average post-test score of the control class mathematical critical thinking ability of 61.75.

Based on the conclusions that have been presented, there is an increase in students' mathematical critical thinking skills.

https://doi.org/10.51276/edu.v4i1.310

Student Activities

Observation sheets are created to obtain one of the types of data supporting the learning effectiveness criteria. This instrument contains three differentiation learning indicators with nine sub-indicators. Observations are carried out by observing student activities carried out during two meetings. The data obtained from the instrument were summarized at the end of the meeting. A mathematics subject teacher, Mr. Ronal Simare-mare, S. Si, conducted data analysis of student activity in mathematics learning. In this study, the average student activity of 2.33 was in a suitable category. This can be seen in the following table:

Table 2. Average Student Activity Score

Indicators	Average Student Activity Score	Criterion
Content Differentiation	2,33	Good
Process Differentiation	2,33	Good
Product Differentiation	2,33	Good

The table above shows that the average student activity in the application of content differentiation is 2.33 in the excellent category, the application of process differentiation is 2.33 in the good category, and the application of product differentiation is included in the excellent category. Thus, student activity in participating in differentiation learning is declared effective can be seen from the average student activity, which is 2.33 in the excellent category. The results of this student learning activity can show that differentiation learning can change students' attitudes toward learning (Karadag & Yasar, 2010).

Teacher's Ability in the Implementation of Differentiation Learning

There are three components in activities in differentiation learning, namely process differentiation, product differentiation, and content differentiation. The ability of teachers to manage and carry out differentiation learning can be seen from the questionnaire of differentiation learning implementation sheets that contain these three components. Observations are carried out by observing student activities carried out during two meetings. The data obtained from the instrument are summarized at the end of the meeting, which is then concluded. The cumulative questionnaire score is then processed and calculated based on the right data processing formula. Here is a table that contains the results of data processing.

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Table 3. Average Score of Teacher Ability in The Implementation of Differentiation Learning

Indicators	Average Score of Learning Implementation	Criterion
Content Differentiation	3	Excellent
Process Differentiation	2,25	Good
Product Differentiation	2,75	Good

From the data above, it can be seen that the average score of teachers' ability to implement content differentiation is 3 with excellent categories, the average value of process differentiation implementation is 2.25 with good categories, and the implementation of product differentiation of 2.75 is in a suitable category. Based on this data, the value of teachers' ability to implement differentiation learning is 2.67, with an excellent category. So teachers are stated to be able to manage to learn very well.

The data shows that the experimental class's average learning readiness score is 51. Furthermore, the data are grouped into two categories: the high learning readiness category with a score above 51 and the low learning readiness category with a score below 51. With these criteria, 18 students have high learning readiness, and 14 have low learning readiness. For simplicity, it can be seen in the following diagram.

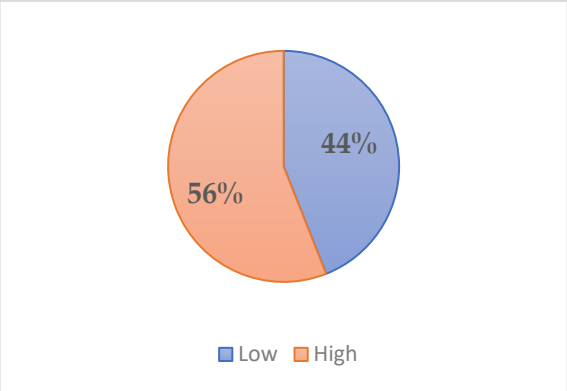

Figure 3. Student Learning Readiness Pie

As for learning interest, it is obtained from the data that the average score is 52.1. Then the data is grouped into two categories: the high learning interest category with a score above 52.1 and the low learning interest category if the score is below 52.1. With these criteria, 19 students have a high interest in learning, and 13 have a low interest in learning. Based on data obtained from the distribution of questionnaires in practical classes with a total of 32 students, it can be concluded that as many as 56.25% of students have high learning readiness.

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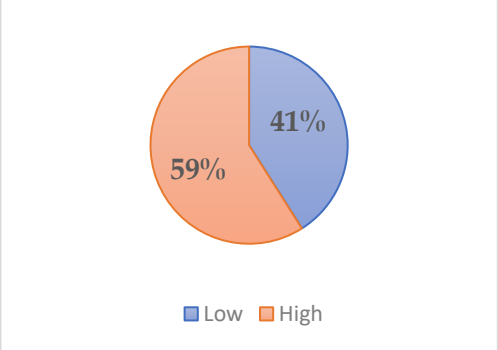

Figure 4. Student Learning Interest

For learning styles, it is known that 21 students belong to the category of visual type learning styles, seven students belong to the auditorial type learning style category, and four students belong to the kinesthetic type learning style category, so it is concluded that student learning styles are a more visual type, namely 21 students.

The learning style in the experimental class can be concluded that 65.6% of students fall into the category of visual learning styles, as many as 21.8% fall into the category of auditorial learning styles, and 12.5% of students fall into the category of kinesthetic learning styles. For more details, you can see the following pie chart.

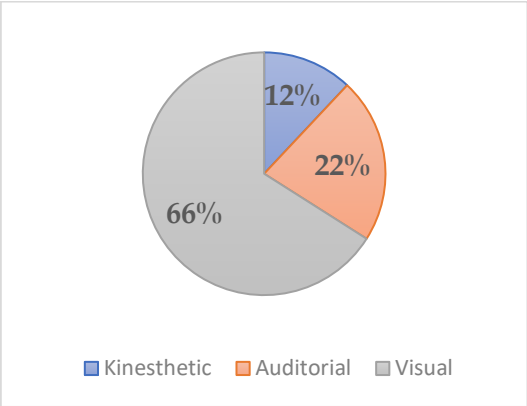

Figure 5. Student Learning Style Pie Chart

Discussion

In this study, several research findings were found, including in terms of student activities, the ability of teachers to manage to learn, and the completeness of student learning. Apart from these three aspects, findings were also related to the results of the initial assessment of students in terms of learning profile assessment, learning readiness assessment, and student interest assessment. The findings will be outlined in a later study.

Learning using differentiation learning in Mathematics learning is effective. This result is in line with research conducted by Aprima, Desy, and Sari, Sasmita, which states

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that differentiation learning is effective in elementary mathematics learning (Aprima & Sari, 2022).

The effectiveness of learning in this study is reviewed from 3 things: student activities, teachers' ability to manage to learn, and student learning outcomes. In terms of student activity, differentiation learning can increase student learning activities to be more active. In addition to increasing activity, differentiation learning can improve student learning outcomes. This is in line with research from I Made Surat which writes that differentiation learning can increase student activity from less active to active. Student learning outcomes increased with classical completion by 65.7% from the initial condition (Surat, 2019), (Syarifuddin & Nurmi, 2022).

Differentiation learning, in addition to being effective for learning, can also facilitate students' different learning needs. In this study, the learning needs facilitated were readiness, learning styles, and learning interests (Herwina, 2021). (Wahyuningsari et al., 2022), (Faiz et al., 2022). The learning styles found in students in this study consisted of 3 categories, namely auditory, visual and kinesthetic learning styles. The interest in learning in this study is categorized into 2, namely high interest in learning and low interest in learning. Learning readiness also consists of 2 categories: high learning readiness and low learning readiness.

D. Conclusion

Based on the results of research and hypothesis testing that has been carried out, the learning process of differentiation runs effectively, which can improve students' mathematical abilities. This can be seen from the difference in the average post-test scores of students in the experimental class and control class of 2.25%, the percentage of students who meet KKM is 62.5%, the average student activity is 76.6%, and also the average level of teacher ability in managing differentiation learning in the experimental class, which is 89%. The results of this study are in line with research conducted by Mulbar, Usman, and the team, which showed results that there was an increase in teacher activity, student activity, and the value of learning outcomes (Mulbar et al., 2017).

The suggestion for further research is that research can be continued to analyze the quality of differentiation learning in mathematics learning and more holistic mapping in the initial assessment of student differentiation. Furthermore, the use of differentiation learning in learning must also pay attention to the teacher's knowledge and cognitive level of the learning application (Stollman et al., 2019).

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