



The Effect of Differentiated Learning on Improving Student Learning Outcomes

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Abstract

This research aims to obtain objective information and examine differences in the abilities of reasoning mathematical students who study with method learning differentiate assistance with RME-based matrix teaching materials from students who use conventional methods. This research uses a quantitative approach with experimental research methods pseudo (quasi-experiment) with type non-equivalent control groups design. The study was carried out in the even semester of the 2022/2023 academic year in the mathematics subject matrix material. The subjects in the research involved students of class XI APHP at SMK Negeri 2 Metro Lampung consisting of class XI APHP 1 as the experimental class and XI APHP 2 as the control class. In the study, the data collected used test beginning (pretest) and the final (posttest) given to the experimental style, and the control class consisted of 4 essay questions. The statistical data obtained were normality, homogeneity, and hypothesis tests, which were processed using the SPSS 16.0 program. Based on the results of the hypothesis test, a significance value (2- 2-tailed) was obtained of 0.000. Therefore, the significance value was <0.05, so it can be concluded that the results of this research show that there is an influence of differentiated learning assisted by RME-based matrix teaching materials on mathematical reasoning abilities. class XI APHP student at SMK Negeri 2 Metro Lampung.

Keywords: Differentiated learning; Mathematical ability; RMS.

Introduction

One of the subjects with a low success rate is mathematics. This is proven by the results of tests carried out by PISA or the Program for International Students Assessment in 2018, where Indonesia was ranked at the bottom (Kattan, 2003; Yan, 2003; Zhou, 2017). Mathematics is an exact science with abstract study objects and is related to reasoning (Dack, 2019; Haugen, 2017). Because the thing of mathematics study is abstract (Pozdeyev, 2018; Varum, 2011), many

students find it difficult to understand material mathematics (Chen, 2018; Francis, 2015), especially in student vocational school (Fu, 2018; Landa, 2016), Which generally still has low reasoning. So, learning methods are needed that can facilitate students' understanding of concrete situations (Aljaser, 2019; Prast, 2018), for example, by implementing learning using a Realistic Mathematical Education approach or abbreviated RME. In mathematics, There is a number of ability that should mastered by the student (Scott, 2016; Sun, 2018). Wrong, the only one is ability reasoning. Reasoning is defined as a process of thinking to find connections between known facts so that conclusions can be reached (ASB Lestari et al., 2023; Lai et al., 2020).

Reasoning in mathematics is the process of thinking logically about mathematical objects to conclude (Attwood, 2020; Steinbauer et al., 2021). Mathematics material taught since vocational school is Wrong. The only one is Matrix (Burga, 2022; Jackson, 2021). Matrix Also No regardless of need ability reasoning student (Choirudin et al., 2021; U Zahroh et al., 2023). Process learning (Triono et al., 2023; Usmiyatun et al., 2021), especially in Elementary schools (Fikri et al., 2023; Yuniwati et al., 2023), is generally implemented passively (Darmayanti et al., 2023; Safitri et al., 2023; Vediany et al., 2022), where teachers reveal material using the lecture method while students listen (Santiago et al., 2023), as a result, students quickly feel bored and bored.

Therefore, the Minister of Education and Culture, Mr. Nadiem Makarim, issued a learning concept called "Freedom to Learn", namely, freedom to think and innovate. "Freedom of Learning" focuses on students being free to learn independently and creatively, while the teacher is only the driving force in learning (Rizki et al., 2022; Sugianto, Cholily, et al., 2022a). In line with the "Freedom of Learning" policy, which focuses on students, teachers must also pay attention to students' diversity of character and abilities in the classroom. To address this, differentiated learning can be applied. Differentiated learning assumes that every child has the opportunity to learn according to himself.

Differentiated learning is the implementation of learning that adapts to the interest or interest of the student, style of learning, and students' learning readiness to achieve improved learning outcomes. Differentiated learning is not learning that differentiates between individual students but rather understanding the strengths and learning needs that students need to know independently (Ahmed et al., 2021; Darmayanti et al., 2022). This research aims to obtain accurate information and examine its different abilities in reasoning mathematically. It is owned by students who carry out differentiated learning, assisted by RME-based Matrix teaching materials with students who carry out conventional learning.

Theoretical Study

Lesson Study activities

Differentiated learning is defined as learning that sees that student As different And dynamic different here. It means every student has other characters, as well as their interests and needs in learning" 8. "Differentiated learning is learning that provides opportunities to grasp concepts, process ideas, and improve results from diversity students in in class" 9. So, The conclusion is that differentiated learning is an adapted learning method to Study every student. There is 3 element That differentiated into differentiated learning to meet students' readiness and learning needs. These 10 3 elements consist of (1) Content differentiation, namely providing various learning materials and activities with various levels of performance that are modified and adapted to student needs; (2) Process differentiation, referring to how to teach lessons based on student's learning styles and needs; (3) Product differentiation, related to students' ways of expressing and expanding their understanding which can be done in various forms. Before implementing differentiated learning, a diagnostic assessment is first given to the students. Diagnostic tests aim to determine the weaknesses students have so that later they can be given treat Which in accordance to overcome these weaknesses 11. Diagnostic assessment can be interpreted as an assessment carried out as a first step to obtain information regarding students' abilities, the mistakes and learning difficulties they experience, as well as what they are experiencing. The cause.

RME Based Matrix Teaching Materials

Teaching material is a collection of material on a particular topic that is arranged in a coherent manner that contains competencies that students will master after learning."12" A matrix is a rectangular arrangement of numbers arranged in rows or columns bounded by brackets". "RME or Realistic Mathematical Education is learning that begins with giving a problem that can with easy for students to understand because it is close to the environment around students, this learning emphasizes process skills in solving issues presented independently."13 So, RME-based matrix teaching materials are a set of materials about matrix Which arranged in a way systematic with use realistic approach or linked circumstances real around student so that easier understood connecting known facts to reach conclusions. In mathematics, mathematical reasoning is defined as the stage of thinking to make mathematical decisions based on existing facts or data, as well as relevant concepts and methods 14.

Sumarmo stated that there are several indicators related to mathematical reasoning abilities. These indicators consist of (1) being able to draw logical conclusions, (2) being able to provide explanations with models, facts, properties and relationships, (3) being able to predict answers and solutions to problems, (4) being able to analyze mathematical situations using patterns And connection because consequence; (5) Capable compile And study conclusion; (6) Able to compose valid arguments; and (7) Able to prepare direct evidence and

indirect evidence.

Research Method

The quasi-experimental method, also known as *Quasi-experimental*, is used by researchers as a research method. Researchers used a "nonequivalent *control group design* " research design, which used two class groups, namely the experimental group and the control group 15. The difference between these two classes lies in the treatment given during the learning process, where the practical class uses differentiated learning methods assisted by RME-based Matrix teaching materials. In contrast, the control class uses conventional methods. Researchers carried out research at SMK Negeri 2 Metro Lampung from February 4, 2023, to February 25, 2023. Subject selection was carried out randomly by taking two classes as classes. Experiment And class control. The class experiment is class XI APHP 1, which consists of 27 students and the Time and Control class is class XI APHP 2, which consists of 25 people students.

Researchers collect data for research needs using tests and supporting documentation. The test was carried out before and after being given the treatment-shaped question pretest And posttest. There is 4 four-question test, Which is shown in the form of a description with covers indicator reasoning mathematically. At the same time, documentation consists of documentation of Photo activity learning, lesson plans, as well as documentation of learning outcomes for students.

Data study obtained from mark *pretest* & *posttest* from class experimental and control class. After the test results data on the question instrument is received, it is then analyzed to find out the results of validity, reliability, level of difficulty of the questions, and the differentiating power test.

Validity Test

Validity Test An instrument that can measure what it wants to measure is said to be a valid instrument 16. Validity test results were obtained using coefficient correlation "Pearson product-moment" help IBM SPSS Statistics 16. A question is said to be good if the calculation is greater than the table using a significance level of 5% or 0.05. The data analysis technique for testing hypotheses uses the t-test, which was previously carried out first by normality tests and homogeneity tests on the *pretest* and *posttest* scores of experimental class and control class students.

Readability Test

Reliability is the test decision results test. An instrument study is called reliable if the result is relatively The same, although Already been used a number of times. To measure the reliability of the instrument using Cronbach's Alpha calculations with the help of IBM SPSS Statistics 25. Questions are reliable if the results of Cronbach's Alpha > 0.6.

Normality Test

To find out whether the data is normally distributed or not, this is done using use test normality. Data used is data pretest and posttest of students from the two classes used. In this research, the Shapiro-Wilk test was carried out for normality testing assisted by IBM SPSS Statistics 16. A significance level of 5% or 0.05 was used. The normality test provisions are as

Homogeneity Test

The homogeneity test aims to determine whether or not the variance of the data used is the same. Data calculations for this homogeneity test use the *Analyze Compare Means - Oneway Anova* formula with the help of IBM SPSS Statistics 16. The data tested for homogeneity are the results of the *pretest* and *posttest* of the

experimental class control class, with a significant value of 5%. The homogeneity test decisions are as follows.

Hypothesis Testing

Test hypothesis done To know if there is a significant difference between the two samples studied with a significance level of 5%. Test the idea using the t-test with the *Analyze-Compare Means Independent T-Test* formula assisted by IBM SPSS Statistics 16. The result is that if the sig (2-tailed) is less than 0.05, then the decision is H_a accepted and H_0 rejected.

Results and Discussion

The quasi-experimental method, also known as *Quasi-experimental*, is used by researchers as a research method. Researchers used a "*nonequivalent control group design*" research design, which used two class groups, namely the experimental group and the control group. The difference.

In this activity, what students did in almost all groups was mixing various objects, especially objects that were liquid and had a soft texture, in one container. This shows the student's need for more understanding in following the instructions in the LKPD and the model teacher's explanation. The second activity to achieve the first learning objective is observing the syringe where the needle has been taken. Only the syringe and piston are left. This experimental activity was to keep the compressibility properties of three forms of objects, and students succeeded in drawing the correct conclusions. All groups correctly answered the compressibility property of the three different states of matter. Solids, sequentially liquids and gases possess the greatest compressibility.

The second learning objective is to describe diffusion events in liquids and gases in everyday life. For the second learning objective, students were given an explanation in advance about the definition of diffusion, then sprayed perfume over the room, after which students were asked to observe how the smell of perfume could reach the students' noses. The second learning objective has been achieved, as evidenced by students explaining how their noses can smell students' aromas at a certain distance from where they spray perfume. The third learning objective is to describe the particles of each state of matter: solid, liquid, and gas. Students still need clarification about how to tell the third particle of the shape object's shape model. The teacher re-explains, starting from the beginning, the properties of solids seen from changes in shape based on the container, compressibility, and diffusion properties. However, students still need to understand. Only two children could understand how to describe the form of the third particle of matter.

After reflecting and making conclusions, the model teacher provides material reinforcement for the properties of solids, liquids, and gases, gives examples of objects, and asks students to imagine each instance of the things mentioned. Finally, students can understand the shape of the third particle of matter. Then, students can independently describe the conditions of solid, liquid, and gas particles. With *Lesson study*, we learn about student activities during learning: students who know and have learning difficulties. Observers from teacher friends help model teachers find students with learning difficulties. Cooperative learning makes it easier for students to understand and find meaningful learning in the material properties of solids, liquids, and gases.

The second cycle was carried out for mathematics subjects. Stages of planning (*plan*) Partner teachers and lecturers discuss to determine teaching materials and learning strategies appropriate to the first plan. Differentiated cooperative learning is the best choice considering the need for students to learn to work together and the presentation of

different learning needs among students. In the second plan, the model teacher presented the design of the Mathematics learning device (RPP) according to the first plan. Partner lecturers and teachers provide input for improvement so the lesson plans offered become joint works of partner teachers and lecturers to be given to students. The learning media used are laptops, LCDs, *PowerPoint Slide Shows*, books/reference materials, Student Worksheets (LKPD), whiteboards, and markers.

The learning model used is problem-based learning and discovery learning with a scientific approach. At the beginning of the learning activity, students are divided into groups with diverse abilities in the hope that there will be collaboration between members. Starting from the prepared LKPD, students collaborate to complete it. By collaborating, students observe, ask, try and process data. LKPD is to guide students to find conclusions according to learning objectives. Submission of apperception at the beginning, the formation of groups, and the distribution of worksheets affect the classroom management model during learning. As a facilitator, the teacher guides each group to ensure a learning process and mutual collaboration between group members. Henceforth, in the presentation session of group discussion results, the teacher manages the class by acting as a moderator during the presentation, up to the reinforcement of the material.

Furthermore, the teacher conducts *an open class (do)* beginning with opening learning activities with greetings and prayers led by students to train students' leadership and religious spirit and remind them of the previous material that has been studied, namely exponential numbers, then relating it to the topic to be reviewed, namely finding the definition of exponential numbers. Displays daily facts in dividing single-celled animals and the volume of a cube-shaped aquarium and its relationship to the learning objectives to be achieved. In this session, the students' enthusiasm began to learn more about the material related to the facts presented.

After conducting *the open class*, reflection was then carried out. Based on the observer's observations, several facts were found that several group members could not work together with group members—waiting for the results of his friend's work. It was also found that several group members who did not follow the steps for working on the LKPD for a week found themselves confused and completed the LKPD and practice questions. Students feel impatient and immediately work on practice questions and eventually encounter difficulties. So, the role of the teacher becomes essential to be a good facilitator. In addition, it was also found that some students did not pay attention to their friends during the presentation. So, it is essential to pay attention to the layout of the LCD or the display media for the results of group discussions so that all students can pay attention. No less important is the teacher's instructions as a moderator to condition students to pay attention to their friends during presentations. So some of the suggestions given are names of students who need special attention, which needs to be applied to a different learning model (differentiation) to achieve learning mastery—also technical matters such as the location of learning media, table setting and others.

The next cycle is on Arabic language subjects. At the planning stage (*Plan*), discussion activities are carried out with partner teachers and lecturers to determine the best learning strategy that might be implemented, starting with the presentation of Arabic teaching tools so that some constructive input is obtained which was not previously thought of by the model teacher to add treasures and learning strategies by made some changes or modifications, such as in LKPD, where at first individuals were assembled into groups considering that Arabic lessons were limited to 1 lesson hour (40 minutes).

In implementing *open classes (do)*, learning Arabic can be carried out according to a predetermined schedule. There is a minor obstacle in that

some students still need to change their uniforms after the sports subject, given the limited time, students are allowed to take part in lessons wearing sports costumes. In the division of groups, some groups are less balanced, especially in numbers, although it does not significantly affect group work results. The number of group members is considered too large, so some students are passive because they need access to the media provided because of the limited number. In the joint reflection activity between model teachers, observers and partner lecturers, many necessary inputs could be used to improve learning Arabic in the future.

In collaboration with colleagues through *lesson study*, there is interaction and communication, so there is input, suggestions, and improvements from differentiated learning plans (Sekaryanti et al., 2023; Sugianto, Cholily, et al., 2022b). Differentiated learning is made in terms of content differentiation in the form of audio, video and practical presentation of material—process differentiation is students' freedom to complete the tasks given and the products produced. Not only do they plan together, but when other lecturers observe how students learn, this can help the model teacher to know in detail about students who are learning and who have not studied. Observations when *open classes* are focused on students so that model teachers do not feel judged because the implementation of learning in class is the shared responsibility of all teachers who make joint plans (Khoiriyah et al., 2022; Sugianto, Darmayanti et al., 2022; Vidyastuti et al., 2022). Based on the results of the observer's observations, most of the students were excited to take part in the learning being carried out. This shows that *lesson study* can improve the quality of education (Juano & Ntelok, 2019; Kongthip et al., 2012; Tanujaya & Mumu, 2020).

Based on the results of the evaluation and reflection carried out at the end of the lesson, data was obtained from the assessment that 85% of students had completed and the learning objectives had been achieved. This shows that differentiated learning has a positive impact, but compiling and implementing differentiated learning takes work and time. It requires a mature process and thought, so one of the solutions offered is through LSLC (*lesson study for learning community*). It can be done jointly and collaboratively to plan learning.

Conclusion

Collaborative activities carried out by lecturers and teachers are packaged as *lesson study* (LS) activities. The stages carried out include planning activities (*plan*), carrying out open class/ *do* (*class*) and observation and reflection (*see*). *Lesson study* (LS) activities have a positive impact on learning. Through *lesson study* (LS) activities, teachers can improve competence, incredibly professional and pedagogical competencies, which are very important in improving the quality of education in schools. Lecturer and teacher collaboration will be able to develop more meaningful learning in improving Higher Order Thinking Skills (HOTS) and students' 4Cs skills. Through *lesson study*, teachers and lecturers collaborate in planning, implementing and reflecting on learning activities with differentiation. In general, students become more enthusiastic, and the results of the evaluation of learning that is carried out can be achieved. The research being conducted is still limited to junior high school students in one of the private schools, for further analysis can be carried out at the high school or tertiary level and can develop LS (*lesson study*) to become LSLC (*lesson study for learning community*).

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