Implementation of Differentiated Learning Process Based on Students' Initial Mathematics Ability

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Abstract. This study was motivated by the low learning outcomes of students in learning mathematics caused by the diverse characters of students, especially in the aspect of students' initial mathematical abilities. This study aims to improve students' learning outcomes in learning mathematics by using process differentiation based on students' initial abilities. The method used in this research is classroom action research (CAR). The research procedure followed the Kemmis & Taggart model, namely planning, action, observation, and reflection which was carried out in 2 cycles. The research subjects were students of class VIII.1 SMP Negeri 29 Bulukumba totaling 21 people, students of class VIII.1 SMP Negeri 10 Parepare totaling 32 people and students of class VIII.5 SMP Negeri 1 Mattiro Bulu totaling 26 people. The collection technique in this study was done through a learning outcome test. The results of research using process differentiation based on the initial ability of students showed an increase in learning outcomes. Based on the results of the research obtained the results of the actions provided, namely in cycle I students experienced an increase in learning outcomes compared to pre-cycle learning outcomes. However, because it has not met the standard of success, namely classical completeness reaching 85% of the students present, the provision of action is continued in cycle II. Then in cycle II students again experienced an increase in learning outcomes from cycle I and had achieved completeness of more than 85% of the students present. Based on the results of the research and discussion, it can be concluded that the application of differentiated learning process based on the initial mathematics ability of students carried out in the even semester of the 2022/2023 school year in three different schools located in South Sulawesi, namely SMP Negeri 29 Bulukumba (subject A), SMP Negeri 10 Parepare (subject B) and SMP Negeri 1 Mattiro Bulu (subject C) can improve students' mathematics learning outcomes.

Keywords: Process differentiation, initial ability, learning outcomes, mathematics

INTRODUCTION

Indonesia is a country that has developed in various sectors, one of which is education [1]. Education is an effort so that humans can develop their potential through the learning process and get recognition from the community [2]. Education acts as a means to shape human personality in acquiring knowledge and skills from teachers to students to achieve predetermined goals. Educational goals that position teachers as educators and students as Students will be realized if learning seems interesting, fun, and meaningful [2]. One of the efforts to realize these educational goals is the concept of independent learning. The concept of independent learning launched by the Indonesian government is freedom of thought. Teachers as the main component in education have the freedom to independently translate the curriculum before it is taught to students in order to be able to answer the needs of students during the learning process

[3]. The proclaimed freedom of learning is in line with Ki Hajar Dewantara's thoughts on education that must be organized in Indonesia.

The purpose of education according to Ki Hajar Dewantara is to guide all the natures that exist in students so that they can achieve the highest safety and happiness both as humans and as members of society [4]. The learning envisioned by Ki Hajar Dewantara also requires teachers to respect and accommodate any differences that exist in students, because every student has the same rights. Therefore, liberating education is needed, one of which is through differentiated learning [5].

Differentiated learning is teaching Students with different ways of thinking and abilities. This requires teachers to understand Students. Teachers can create powerful lesson plans, assessments and evaluations so that they have high expectations of students' different strengths [6]. Differentiated learning is a very important way of thinking about teaching and learning in the 21st century [7]. In differentiated learning there are at least 4 components, namely: (1) content, which includes what Students learn; (2) process, which is how Students process ideas and information; (3) product, how Students show what they have learned; (4) learning environment, how Students work and feel in learning [6].

Process-differentiated learning emphasizes differentiated learning according to Students' abilities. The class must be modified in such a way that different learning needs can be accommodated properly [6]. Modified learning in question is activating learning by focusing activities on the material being learned, connecting material that has not been mastered, providing opportunities for students after learning; Involving actual learning activities, such as modeling, exercises, demonstrations, or educational games; Grouping activities, namely grouping students according to their initial abilities [8].

Initial ability is a basis of knowledge that is used to dig deeper into other knowledge that has a relationship with the initial ability [9]. The initial ability of students is a determining factor in the success of mathematics learning [10]. Each individual has different initial math abilities. The initial mathematical abilities of students affect their mathematics learning outcomes [9] so that it is necessary to develop a learning approach to accommodate the initial mathematical abilities of students in order to maximize the mathematics learning outcomes they can get.

Learning outcomes can be defined as something that students can do that they could not do before. Learning outcomes can be used as a benchmark to identify and evaluate learning objectives [11]. As one of the benchmarks for measuring the success of the learning process, learning outcomes reflect the results of the learning process that shows the extent to which students, teachers, and the learning process achieve predetermined goals [12].

In mathematics learning that has been conducted by researchers on junior high school students in various regions in South Sulawesi, namely SMP Negeri 29 Bulukumba, SMP Negeri 10 Parepare and SMP Negeri 1 Mattiro Bulu, the problem of low student learning outcomes is obtained. When working on the student worksheet in groups, there are students who do not participate in working on LKPD, especially students with low initial mathematics ability. Whereas working on LKPD as assessment as learning is one part of the learning process that must be followed by students to achieve learning objectives. In addition, students who do not actively participate in learning divert their activities by talking and walking during learning, making teaching and learning activities less conducive. These various factors cause Students to be unable to do the individual assignments given, thus obtaining low learning outcomes.

In an effort to solve these problems, a learning strategy that considers the characteristics of students is needed. This is especially in the aspect of learning readiness in the form of initial abilities possessed by students. The learning strategy to be applied must be able to make students not have dependence on other students who have better initial mathematical abilities than them in the learning process. So that all Students can actively participate in learning activities and achieve good learning outcomes.

One of the strategic solutions that can be used to deal with these problems is to use differentiated learning processes. Various studies have been conducted to examine the use of differentiated learning (process content, and product) in learning activities. Among them are research from Nurasiah which shows there is an increase in the average value of learning outcomes in the mathematical communication skills of students taught by using differentiated learning and research from Ahmed Husein which shows there is a strong relationship between the use of differentiated instruction and the improvement of student learning outcomes [13][14].

When teachers implement process differentiation, they teach the same concept or skill to every student. However, the way each student understands the topic or skill may vary. Teachers should vary the activities that students use to master the concept or skill. They can decide how best to do this by considering their students' readiness levels, interests or learning profiles. Teachers may break students into groups or pairs to work on different activities or may assign individual tasks [15]. Another way of differentiating the process for heterogeneous classes is by designing tiered learning [16]. When teachers structure lessons, they can design differentiated instruction for students at different initial

ability levels: low, intermediate, and high. Although the students have to master the same core content or skills, the way they do it differs.

Based on the background of the problem, namely the lack of student learning outcomes in learning mathematics and the study of differentiated learning processes, the authors conducted research on the application of differentiated learning processes based on students' initial mathematics abilities to improve student learning outcomes.

RESEARCH METHODS

This research was conducted in three different schools but with the same level, namely students of grade VIII of Junior High School. The three schools were SMP Negeri 29 Bulukumba, SMP Negeri 10 Parepare, and SMP Negeri 1 Mattiro Bulu. The research subjects at SMP Negeri 29 Bulukumba were students of class VIII.1 totaling 21 people, students of SMP Negeri 10 Parepare class VIII.1 totaling 32 people and students of SMP Negeri 1 Mattiro Bulu class VIII.5 totaling 26 people. This research was conducted in the even semester of the 2022/2023 school year.

The method used in this research is Classroom Action Research (CAR) which consists of the stages of planning, action, observation, and reflection adopted from Kemmis & Taggart [17]. The research procedure by following the flow of CAR, namely planning by compiling research tools consisting of learning devices (compiling lesson plans, student worksheets, teaching materials and learning media), observation sheets, and evaluation instruments. The second stage is the implementation of action, in this case the application of differentiated learning process. The third stage is observation by observing the process of differentiated learning. At this stage the researcher must describe the type of data collected, how to collect and data collection tools or instruments. Then the fourth stage is reflection, by identifying the shortcomings and advantages of implementing differentiated learning processes at the end of the learning cycle. At this stage it is very appropriate to do when the implementing teacher has finished taking action, then hopes with the researcher to discuss the implementation of the action plan, record the results of observations and implementation of learning, evaluate the results of observations, analyze learning outcomes, improve pre-cycle 1 weaknesses, then improve weaknesses in cycle 1 and cycle II [18].

The following is a description of the stages of classroom action research (CAR) adopted from Kemmis & Taggart [17].

FIGURE 1. Stages of Classroom Action Research (CAR)

The data collection technique in this study used a learning outcome test. A learning outcome test is a test used to measure a person's achievement in a field as a result of a learning process carried out intentionally in the form of knowledge, understanding, skills, attitudes and values [19]. Data collection on student learning outcomes after being given action is collected by evaluation techniques at the end of the action. This learning outcome test is used by researchers to measure the learning outcomes of 8th grade Mathematics students on the material "Opportunities" with the Minimum Completion Criteria (KKM) of 75. In this study, students will be said to be successful if they have reached the percentage standard ≥ 85% of the number of students present. Furthermore, the data was analyzed using the classical completeness formula.

$$Score = \frac{Number\ of\ students\ completed}{Total\ number\ of\ students}$$

After the quantitative data results were calculated using simple statistical formulas, then the data were analyzed using classical completeness analysis. The results of classical calculations are grouped into 5 categories. The criteria for classical completeness can be seen in table 1.

TABLE 1. Criteria for Classical Completion

Success Rate (%)	Qualification
Score ≥ 80	Very Good
$60 \leq$ Score > 80	Good
$40 \leq$ Score > 60	Fair
$20 \leq$ Score > 40	Deficient
Score < 20	Very Poor

RESEARCH RESULTS AND DISCUSSION

Differentiated learning views Students differently and dynamically where the teacher sees learning from multiple perspectives [20]. Differentiated learning is one of the strategies that teachers can use to meet the needs of each learner. In this research, the implementation of differentiated learning process is conducted in mathematics subject. The term "process" refers to the activities carried out by the Students as well as the treatment given by the researcher based on the Students' initial abilities. Activities carried out by students are activities that are meaningful to participants as a learning experience in the classroom, not activities that have nothing to do with what is being learned [21]. While the treatment carried out by the researcher is different actions given to students according to their initial abilities.

Pre-cycle Description

Based on the results of the learning formative test conducted in class VIII.1 SMP Negeri 29 Bulukumba which was attended by 19 participants (Subject A), class VIII.1 SMP Negeri 10 Parepare which was attended by 31 students (Subject B), and class VIII.5 SMP Negeri 1 Mattiro Bulu which was attended by 25 students (Subject C), the results were far from expectations. This is because there are still many students who have not reached the minimum completeness criteria that must be achieved, namely 75. The results of the pre-cycle formative test can be seen in the following table.

TABLE 2. Pre-cycle Learning Outcomes

No	Aspect	Description of subject A	Description of subject B	Description of subject C
1	Number of students present	19 students	31 students	25 students
2	Number of students complete	10 students (52.63 %)	20 students (64.52 %)	14 students (56 %)
3	Number of students who did not complete	9 students (47.37%)	11 students (35.48%)	11 students (44 %)
4	Total score	1420	2030	1752
5	Highest score	100	100	92
6	Lowest score	50	30	35
7	Average score	74,74	71.93	70.08

Table 2 shows that in subject A there were 10 Students who were complete and 9 Students who were not complete. The highest score obtained by Students is 100 and the lowest score is 50. The average score achieved is 74.74. in subject B there are 20 Students who are complete and 11 Students. The highest score obtained by Students is 100 and the lowest score is 30. The average score achieved is 71.93. in subject C there are 14 complete Students and 11 Students. The highest score obtained by Students is 92 and the lowest score is 35. The average score achieved is 70.08. Pre-cycle learner outcome data can be depicted in the following diagram.

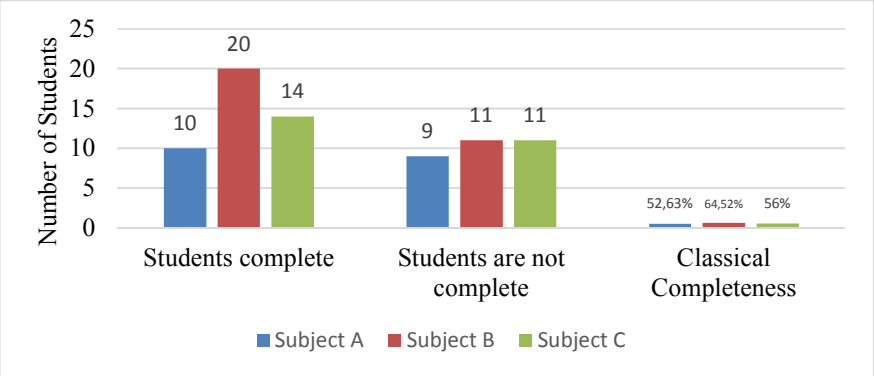

FIGURE 2. Diagram of Pre-Cycle Learning Outcomes

The diagram above shows that the classical completeness of pre-cycle learning of subject A is 52.63% and is classified as sufficient, the classical completeness of pre-cycle learning of subject B is 64.52% and is classified as good and the classical completeness of pre-cycle learning of subject C is 56% and is classified as sufficient. so it s necessary to take action for each research subject so that the classical completeness of students can increase and in accordance with expectations.

Cycle I Description

After obtaining pre-cycle learning outcome data, then the author provides action in the form of differentiated learning process at the next meeting. The implementation of learning is adjusted to the learning plan that has been made before. Briefly the sequence of the learning process in cycle I is as follows.

a. Planning
   In cycle I, the author compiled research tools consisting of learning devices (compiling lesson plans in accordance with differentiated learning, student worksheet, teaching materials and learning media), observation sheets, and evaluation instruments in the form of learning outcomes tests.
b. Action
   The action taken is in accordance with the learning plan that has been prepared previously, namely process differentiated learning based on the initial mathematical abilities of students. The learning activities carried out are students divided into groups based on their initial mathematical abilities. Then each group of students is given differentiated learning process. In the group of learners who have high abilities, the author only provides reading material or videos for them to study on their own in completing the student worksheet given. In the group of learners who have moderate ability, the author provides reading material or video then the researcher gives a little explanation and then they process the information obtained to complete the given student worksheet. While in the group of learners who have low abilities, the author asks students to do demonstrations or practices while listening to explanations and directions from researchers to complete the given student worksheet. After that, students are given a learning outcome test to evaluate learning.
c. Observation
   Observations were made during the process of providing action both by researchers who acted as teachers and those who acted as observers. The type of data collected is quantitative data from test results and qualitative data in the form of learning activity notes. The data on the results of giving student learning outcomes tests are presented in the following table.

TABLE 3. Cycle I Learning Outcomes

No	Aspect	Description of subject A	Description of subject B	Description of subject C
1	Number of students present	15 students	27 students	26 students
2	Number of students complete	12 students (80 %)	22 students (81.28 %)	19 students (73.08 %)
3	Number of students who did not complete	3 students (20%)	5 students (18.72%)	7 students (26.92%)

4	Total score	1230	2276	2040
5	Highest score	100	100	100
6	Lowest score	40	60	35
7	Average score	82	84.29	78.46

Table 3 shows that for subject A in cycle I there were 12 students who were complete and 3 students who were not complete, the highest score obtained by students was 100 and the lowest score was 40 with an average score of 82. For subject B in cycle I there were 22 students who were complete and 5 students who were not complete, the highest score obtained by students was 100 and the lowest score was 60 with an average score of 84.29. For Subject C in cycle I there were 19 students who were complete and 7 students who were not complete, the highest score obtained by students was 100 and the lowest score was 35 with an average score of 78.46.

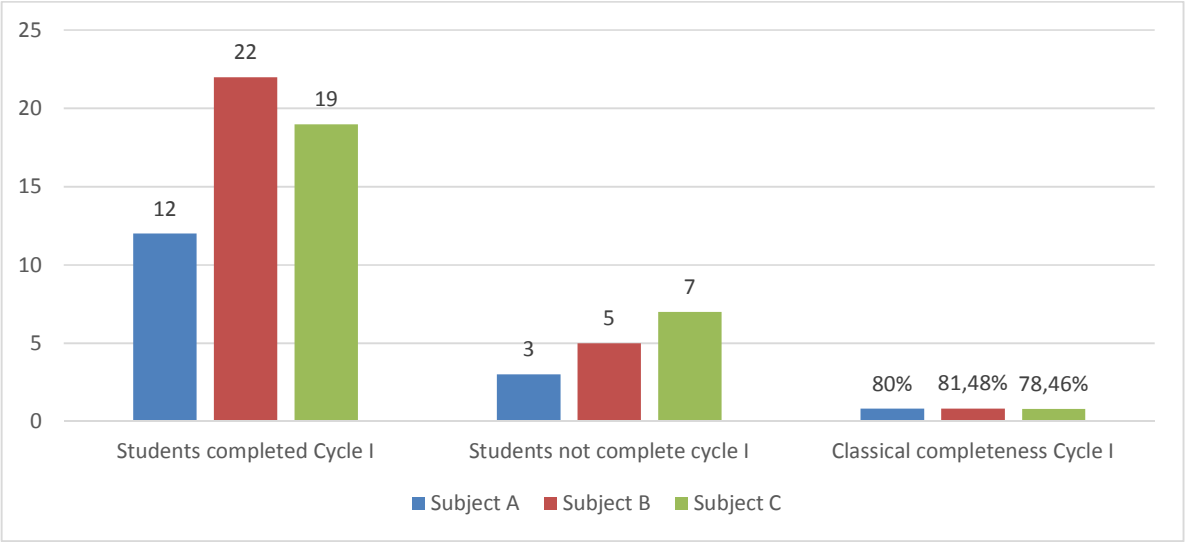

FIGURE 3. Cycle I Learning Outcome Completion Diagram

d. Reflection

Reflection activities are needed to improve the learning process in the next cycle. Based on the results of observations in learning and test results obtained that the learning outcomes of students have not reached the expected target. Then the researcher needs to reflect on the following things:

1) Teachers must be more extra in terms of guiding students, especially groups of low ability students.
2) Use time as effectively as possible so that all planned activities can be carried out.
3) Establish a good relationship with students so that students do not feel afraid or embarrassed to ask questions.

Cycle II Description

After obtaining data on learning outcomes in cycle I, then the author again provides action in the form of differentiated learning processes at the next meeting by considering the results of the reflection at the previous meeting. The sequence of the learning process in cycle II is as follows.

a. Planning

In cycle II, the author compiled research tools consisting of learning devices (compiling lesson plans in accordance with differentiated learning and the results of reflection on cycle I, student worksheet, teaching materials and learning media), observation sheets, and evaluation instruments in the form of learning outcomes tests.

b. Action

The action taken is in accordance with the learning plan that has been prepared previously, namely process differentiated learning based on the initial mathematical abilities of students. The learning activities carried out are students divided into groups based on their initial mathematical abilities. Then each group of students is given

differentiated learning process. In the group of learners who have high abilities, the author only provides reading material or videos for them to study on their own in completing the student worksheet given. In the group of learners who have moderate ability, the author provides reading material or video then the researcher gives a little explanation and then they process the information obtained to complete the given student worksheet. Whereas in the group of learners who have low abilities, the author asks students to do demonstrations or practices while listening to explanations and directions from researchers to complete the given student worksheet. For the group of low ability learners, the author is more intense in providing assistance than in the previous meeting, especially to students who are still less active in learning. After the learning process, students are given a learning outcome test to evaluate learning.

c. Observation

Observations were made during the process of providing action both by researchers who acted as teachers and those who acted as observers. The type of data collected is quantitative data from test results and qualitative data in the form of learning activity notes. The data on the results of giving student learning outcomes tests are presented in the following table.

TABLE 4. Cycle II Learning Outcomes

No	Aspect	Description of subject A	Description of subject B	Description of subject C
1	Number of students present	18 students	31 students	26 students
2	Number of students complete	18 students (100%)	27 students (87.09%)	24 students (92.31%)
3	Number of students who did not complete	0 student (0%)	4 students (12.91%)	2 students (7.69%)
4	Total score	1620	2800	2212
5	Highest score	100	100	100
6	Lowest score	80	70	65
7	Average score	90	90.32	85.08

Table 4 shows that for subject A in cycle II there were 18 students who were complete and no students who were not complete or the learning outcomes of all students present at the meeting met the KKM, the highest score obtained by students was 100 and the lowest score was 80 with an average score of 90. For subject B in cycle II there were 27 students who were complete and 4 students who were not complete, the highest score obtained by students was 100 and the lowest score was 70 with an average score of 90.32. For Subject C in cycle II there were 24 students who were complete and 2 students who were not complete, the highest score obtained by students was 100 and the lowest score was 65 with an average score of 85.08.

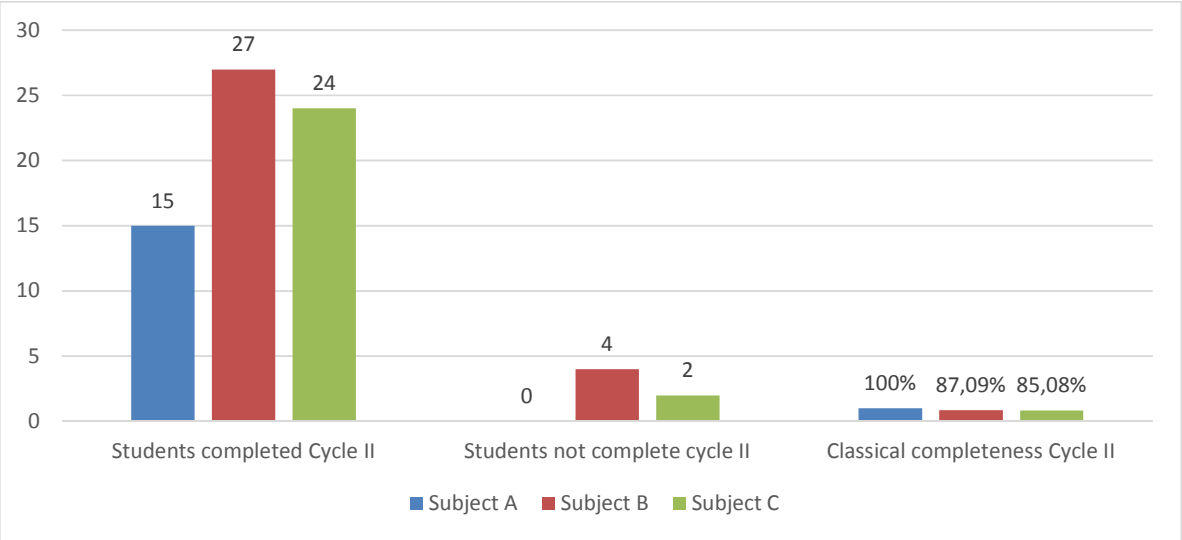

FIGURE 4. Cycle II Learning Outcome Completion Diagram

d. Reflection
The reflection that was carried out after the learning activities in cycle II was that there were changes, which in detail can be explained as follows.
1) Learners began to feel comfortable and did not feel awkward or embarrassed to ask questions when they did not understand.
2) The use of time allocation has been effective.
3) There is an increase in student learning outcomes.

Discussion of Research Results

Based on the results of research on pre-cycle activities, cycle I and cycle II can be described in accordance with the stages of class action research (CAR) as follows.

1. Planning
   The planning referred to here is the making of lesson plan and other teaching tools. The application of differentiated learning process specific to mathematics was chosen as a problem-solving strategy in this study. The process aspect in differentiated learning is aimed at students who have diverse initial mathematics abilities. This plan was also made by considering the results of reflection on the previous meeting.
2. Action
   The actions given in the learning process are adjusted to what has been planned previously. The actions emphasized in this study are in cycle I and cycle II learning activities carried out are students divided into groups based on their initial mathematical abilities. Then each group of students is given a differentiated learning process. In groups of learners who have high abilities, researchers only provide reading material or videos for them to study on their own in completing the student worksheets given. In the group of learners who have moderate ability, the teacher will provide reading material or video then the researcher gives a little explanation and then they process the information obtained to complete the student worksheet given. Whereas in the group of low ability learners, the researcher asks learners to do a demonstration or practice while listening to explanations and directions from the researcher to complete the student worksheet given.
3. Observation
   Observations were made during the process of providing action both by researchers who acted as teachers and those who acted as observers. The type of data collected is quantitative data from test results and qualitative data in the form of learning activity notes. The data was obtained by means of students being given a mathematics learning outcomes test after giving action. In addition, the results of observers' observations of teacher and learner activities in the learning process were used as additional data to reflect on the learning process.
   Based on the results of observations, the results of the actions provided were that in cycle I students experienced an increase in learning outcomes from learning from pre-cycle learning outcomes. However, because it has not met the standard of success, namely classical completeness reaching 85% of the students present, the provision of action is continued in cycle II. Then in cycle II students again experienced an increase in learning outcomes from cycle I and had reached completeness of more than 85% of the students present.
4. Reflection
   The results of the reflection on pre-cycle learning are the need for learning innovation to improve student learning outcomes. Based on the results of this reflection, process differentiated learning was designed. The results of reflection on cycle I learning obtained data that the results of students have increased but have not reached the expected percentage. In addition, information was obtained from the observer that the teacher was still not optimal in providing assistance in the low ability group so it was necessary to re-plan the learning to be carried out in cycle II. The results of reflection on cycle II learning obtained that the learning outcomes of participants have increased with the expected percentage and learning activities have also been in accordance with what has been planned.

CONCLUSIONS

Based on the results of the research and discussion, it can be concluded that the application of differentiated learning process based on students' initial mathematics ability carried out in the even semester of the 2022/2023 academic year in three different schools located in South Sulawesi, namely SMP Negeri 29 Bulukumba (subject A), SMP Negeri 10 Parepare (subject B) and SMP Negeri 1 Mattiro Bulu (subject C) can improve students' mathematics

learning outcomes. From the two cycles conducted using differentiated learning process based on initial ability, it was obtained that classical completeness in cycle I for each research subject: subject A was 80% with an average score of 82; Subject B was 81.28% with an average score of 84.29; Subject C was 73.08% with an average score of 78.46. The acquisition of classical completeness in cycle II for each research subject: subject A is 100% with an average score of 90; Subject B is 87.09% with an average score of 94.32; Subject C is 92.31% with an average score of 85.08.

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