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Effectiveness of Differentiated Learning in Improving Literacy and Numeracy of Primary School Students

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SQ, ARN and LM assisted researchers in preparing instruments and collecting data. Meanwhile, author NI includes research instrument development, data collection and data analysis. All authors read and approved the final manuscript.

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ABSTRACT

Literacy and numeracy are one of the critical thinking skills in solving daily life problems that must be possessed by every individual. Based on data obtained from PISA, the level of literacy and numeracy skills in Indonesia is still relatively low, which ranks 62nd out of 70 countries. Therefore, efforts are needed to improve literacy and numeracy skills, one of which is through Differentiated Learning Activities. This study aims to determine the effectiveness of differentiated learning implementation in improving students' literacy and numeracy skills. The subjects of this study were fifth grade students one of elementary school in Pasuruan with a total of 18 students. The instruments used in this study were pretest and post-test sheets, observation sheets, and documentation. The method used in this research is an experiment with a pre-experimental design

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(One Group Pretest-Posttest) using the t test. Data collection techniques are observation, tests (pretest and posttest), and documentation. This study found that the application of differentiated learning can improve the literacy and numeracy skills of elementary school students. This is obtained from the results of the t test which shows that literacy skills obtained a significance value = 0.04452 and numeracy skills obtained a significance value = 0.000938 with α = 0.05. Based on the test criteria that the significance value <0.05 means that differentiated learning can improve students' literacy and numeracy skills. In addition, the average score of the post-test results on literacy skills is 73.611. While the average score of the post-test results on numeracy skills is 70.277 so that the average result of normalized gain with a literacy ability value of 0.53 and a numeracy ability value of 0.58. The differentiated learning activities that have been carried out can improve students' literacy and numeracy skills.

Keywords: Differentiated learning; literacy; numeracy.

1. INTRODUCTION

"Literacy and numeracy are general and fundamental competencies. Literacy is the language ability possessed by a person in communicating such as reading, speaking, listening and writing" [1,2]. Literacy refers to a person's ability to read, write, understand, and analyze written and spoken texts. It includes the ability to think critically and solve problems, as well as the ability to understand and use information [3]. Literacy is the ability to identify, understand, interpret, create, communicate, and write about a variety of topics [4,5]. In addition, literacy is the ability to analyze a reading and understand the concepts behind the reading. While numeracy is the ability to apply number concepts and arithmetic operation skills in everyday life and the ability to explain information around us [6,7]. Meanwhile, numeracy refers to a person's ability to understand, use, and manipulate numbers. This includes the ability to perform basic arithmetic operations, solve math problems, and use data in relevant contexts [8,9].

Literacy and numeracy skills are used by everyone to develop their potential and participate in the social environment [10]. Literacy and numeracy skills are the basis for students to understand the previous material before students go to a higher level [11,12]. Students with good literacy and numeracy can easily move to the next level to gain more knowledge. Literacy and numeracy skills can create a foundation for skilled reading and numeracy in future development. Through appropriate learning, literacy and numeracy skills can be optimally developed [1]. "It is very important for students to solve problems that exist in everyday life. These abilities are not only limited to school learning, but are important to apply in everyday life. Literacy and numeracy help a person to gain the basic skills needed to achieve success in life. It aims to form Indonesian human resources who are able to compete and collaborate in the management of natural resources for the welfare of the nation and state" [13].

"Based on research conducted by the Program for International Student Assessment (PISA), it is found that the level of literacy and numeracy in Indonesia is still relatively low. Indonesia ranks 62nd out of 70 countries, or is in the bottom 10 countries with low literacy levels (OECD)" [8]. "Indonesia also has an average Reading Literacy Activity Index (Alibaca) compiled by the Ministry of Education and Culture (Kemendikbud) in 2019, the results are still quite sad. Indonesia's Alibaca is still relatively low where the points are only 37.32 out of 100. The indicators measured by the Alibaca index include skills, access, alternatives, and culture" [14]. "In addition, basic mathematical concepts such as number counting operations have generally been mastered by students, but the skills to apply these concepts to real world situations and unstructured problems are sometimes neglected" [15].

"Based on these facts, efforts to improve literacy and numeracy skills need to be encouraged. One of them is improving students' literacy and numeracy skills by implementing differentiated learning" [16]. Differentiated learning is an effort to adjust the learning process by providing a variety of ways through differentiation of content, process, product and learning environment and initial assessment to meet the individual learning needs of each student. With the implementation of differentiated learning, students can learn according to their needs because each student has different characteristics so that the treatment is also different. There are several studies on the application of differentiated learning that can

improve literacy and numeracy skills. Research conducted by Kj & Prado [17] entitled the application of problem-based learning with differentiated learning strategies can improve student learning outcomes. The study explains that with differentiated learning student learning outcomes can improve. In addition, research by Liliawati et al. [13] who applied the differentiation approach in the inquiry model so as to improve students' numeracy skills compared to classes that only applied the inquiry model alone. This is in line with Setyawati [18] research that implementing differentiated learning can improve students' understanding of a material.

"Differentiated learning is a cyclical process of finding out about students and responding to their learning based on a variety of different needs. These student needs include student learning readiness, student interests and student learning profiles. When teachers continue to learn about the diversity of their students, professional, efficient and effective learning will be realized" [19,20]. Differentiated learning is a curriculum modification where each child can learn in a class with different abilities [21,22]. Differentiated learning is a strategy or pattern of developing and implementing learning in schools that is developed to facilitate the optimization of the development of the potential or different competencies of each child in a class through a variety of content, processes and products, which are developed by considering the diversity of their readiness, interests and learning styles to achieve the same minimum learning objectives or competencies [23,24]. "In responding to student readiness, teachers can relate students' positive thoughts about the new material to be taught and the teacher's potential in the learning process to be better. Meanwhile, interest in learning by recognizing students' interests, namely teachers can plan interesting and meaningful learning. Recognition of students' interests can spur their motivation to learn, students' learning choices, namely learning preferences are the tendency of certain ways that students use in processing what must be learned. Learning profiles consist of learning styles, intelligence and environmental preferences" [16,25]. This is in line with the Minister of Education and Culture of the Republic of Indonesia Ristek confirmed that by the end of 2020 the goal of education in Indonesia is to develop learning that supports students, learning that frees thinking, and education that maximizes student potential.

Based on the explanation above, it is necessary to conduct research regarding the effectiveness of implementing differentiated learning in improving students' literacy and numeracy skills. Therefore, in this study the problem formulation was determined as follows:

1. Can the application of differentiated learning improve students' literacy and numeracy skills?
2. How effectively can differentiated learning improve students' literacy and numeracy skills?

This needs to be done because it aims to determine the effectiveness of the differentiated learning being implemented.

2. MATERIALS AND METHODS

This research is a quantitative study using an experimental method with a pre-experimental design (One Group Pretest-Post test) where the treatment given can be known more accurately because it can be compared with the situation before treatment [26]. This method is used because the treatment is only given to one class, which means that there is no control class or comparison class. The research procedures carried out include: Problem identification, determining and compiling research instruments, data collection, and data analysis.

Description:

O1 = Initial test before treatment (Pre-Test)
X = Treatment in the form of Differentiated Learning
O2 = Final test after treatment (Post-Test)

Table 1. N-Gain classification

N-Gain Value	Category
$N-Gain > 0.70$	High
$0.30 < N-Gain < 0.70$	Medium
$N-Gain < 0.30$	Low

Source: (Timbola et al., [16])

The study population was Grade 5 students one of elementary school in Lekok District, Pasuruan Regency. The sample was taken from all Grade 5 totaling 18 students, consisting of 8 male students and 10 female students.

The instrument in this study was in the form of a test of students' numeracy and literacy skills after the learning activities were carried out. This instrument consists of 20 questions consisting of 12 multiple choice, 8 true/false questions. The test questions are taken from the Educational Assessment Center so they have been validated. The test was used to determine the achievement of students' literacy and numeracy skills. The data collection techniques used were observation, tests (pretest and posttest), and documentation.

Quantitative data analysis regarding the effectiveness of differentiated learning in improving students' literacy and numeracy skills is the one sample t-test. Before going through the stages of the one sample t-test test, first conduct a data normality test as a prerequisite test. The hypotheses in this study are

Ha: Differentiated learning can improve students' literacy and numeracy skills.

H0: Differentiated learning does not improve students' literacy and numeracy skills.

Testing criteria:

a) If the significance value > 0.05 then H0 is accepted and Ha is rejected.

b) If the significance value is <0.05 then H0 is rejected and Ha is accepted.

In addition, the effectiveness analysis can also be seen from the data from the learning outcomes test results given in the form of pretest-posttest assessments, namely calculating the difference between pretest and posttest results using the normality gain (N-Gain) test using the following formula

$$N\ Gain = \frac{Posttest\ score - Pretest\ score}{100 - Pretest\ score}$$

The results of the N-Gain calculation obtained will then be classified into Table 1.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Differentiated learning process in the classroom

Before the implementation of differentiated learning is carried out, an initial assessment is carried out related to the learning style and interests of students so that the material can be received in a more effective way. These observations are made so that the implementation of learning is in accordance with the needs of students. The learning process begins with a real-world context that is close to the lives of students. From this problem, students are then given an explanation related to the phenomenon either by utilizing learning resources in the form of books, posters, or learning videos. After that, students are grouped based on their interests, namely drawing, singing, and playing cards. The group is then given tasks related to the material studied through various processes, so this activity is referred to as process differentiation. In accordance with the opinion of Tomlinson [27] that “differentiation is a teaching and learning process where students learn subject matter based on their abilities, what they like, and their individual needs so that they are not frustrated and feel like failures during the learning process”.

By going through various processes, of course, the products produced by students also vary. Singing groups produce products in the form of songs, playing card groups produce products in the form of card arrays, as well as drawing groups that will produce products in the form of images. After the learning process is carried out, students are also given an evaluation sheet to measure their understanding of the material previously learned. From the results of the differentiation of processes and products that have been carried out in learning, it greatly

impacts the activities and understanding of students. “Differentiated learning is able to help students achieve optimal learning outcomes, because the products they will produce are in accordance with their interests and learning styles [28,19]. Moreover, differentiated learning is considered to be able to increase students' learning motivation” [29]. “This is because students enjoy learning with flexible grouping in differentiated learning” [30].

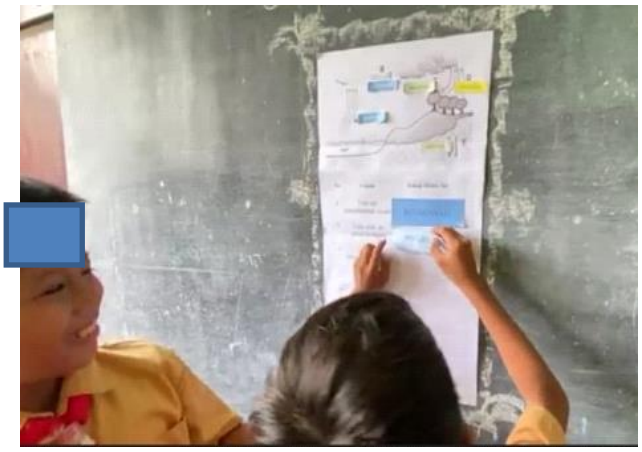

Fig. 1. Playing card group

Fig. 2. Group singing

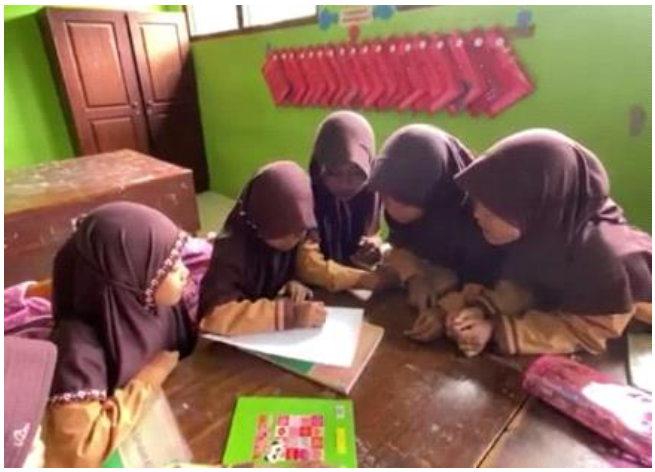

Fig. 3. Drawing group

Table 2. Descriptive statistical data of pretest, posttest and N-gain

Ability Type	Average Score		
	Pretest	Postes	N-Gain
Literacy	43,33	73,611	0,53
Numeracy	28,88	70,277	0,58

Table 3. Normality test results

Component	Test	L Count	L Table	Interpretation
Literacy	Pre Test	0,120798664	0,2	Normal
	Post Test	0,124325255	0,2	Normal
Numeracy	Pre Test	0,124738996	0,2	Normal
	Post Test	0,158006275	0,2	Normal

Table 4. Literacy T-test

	Pre-Test	Post-Test
Mean	43,33333	56,11111
Variance	279,4118	395,7516
Observations	18	18
Pooled Variance	337,5817	
Hypothesized Mean Difference	0	
df	34	
t Stat	-2,08635	
P(T<=t) one-tail	0,02226	
t Critical one-tail	1,690924	
P(T<=t) two-tail	0,04452	
t Critical two-tail	2,032245	

Table 5. Numeration T-test

	Pretest	Postest
Mean	28,88889	52,5
Variance	198,6928	565,4412
Observations	18	18
Pooled Variance	382,067	
Hypothesized Mean Difference	0	
df	34	
t Stat	-3,62383	
P(T<=t) one-tail	0,000469	
t Critical one-tail	1,690924	
P(T<=t) two-tail	0,000938	
t Critical two-tail	2,032245	

3.1.2 Improving students' literacy and numeracy skills

This section will present the improvement of students' literacy and numeracy skills between before and after learning by using differentiated learning. Peningkatan kemampuan literasi dan numerasi siswa dapat diperoleh dari data pretest, posttest, dan rata-rata gain ternormalisasi. Kemampuan literasi dan numerasi pretest, posttest dan N-Gain ditunjukkan pada Tabel 2.

Table 2 shows that based on the results of the pretest for the average score of students' literacy and numeracy skills are still relatively low. Rata-rata skor pretes kemampuan literasi yaitu 43,33 dan rata-rata skor kemampuan numerasi yaitu 28,88. But after the learning process with differentiated learning, students' literacy and numeracy skills have increased, the average score of the post-test results on literacy skills is 73.611. While the average score of post-test results on numeracy skills is 70.277. The

increase in students' literacy and numeracy skills can also be seen from the results of the average normalized gain with a literacy skill value of 0.53 and a numeracy skill value of 0.58. Both increases in ability are included in the moderate category. Although the category is moderate, it shows that there is an increase in students' literacy and numeracy skills after differentiated learning is applied.

This is in line with what is explained Herwina [28] that "the application of differentiated learning can improve student learning outcomes from the predetermined achievement targets". Dalila et al. [19] also stated that "there was an increase in student learning outcomes in academic ability after learning using a differentiated approach and differentiated learning can improve student literacy skills. These results are also in accordance with the results of the t test". However, before conducting the t test, a normality test is carried out first to determine whether the data that has been collected is normally distributed or taken from a normal population. The following results of the normality test are shown in Table 3.

Thus the results obtained L Count < L Table mean that the data is normally distributed. This means that the research results apply to the entire population. After conducting the normality test, the t-test was conducted to determine the effectiveness of differentiated learning in improving students' literacy and numeracy skills. The following are the t-test results on literacy skills in Table 4 and numeracy skills in Table 5.

Table 5 shows that the t-test data on literacy skills obtained a significance value = 0.04452 with $\alpha = 0.05$. Based on the test criteria that the significance value <0.05, H0 is rejected and Ha is accepted. This means that differentiated learning can improve students' literacy skills.

Table 5 shows that the t-test data on numeracy skills obtained a significance value = 0.000938 with $\alpha = 0.05$. Based on the test criteria that the significance value <0.05, H0 is rejected and Ha is accepted. This means that differentiated learning can improve students' numeracy skills.

Based on the research results, it was found that implementing differentiated learning in the classroom can improve students' literacy and numeracy. This is reinforced by the opinion (Mulyawati et al., 2022) that differentiation is providing opportunities for students to show what students understand. In addition, in this way teachers can find out what methods should be given to students to facilitate students' different needs. Student needs can be identified through diagnostic assessments so that from the results of the diagnostic assessment, teachers can design learning that is tailored to student needs. (Smale-Jacobse et al., 2019) [27,31,32].

One of the values and roles of teachers is to create learning that supports students, namely learning that liberates students' thinking and potential. Differentiation can be applied to content, processes and learning products in accordance with research that has been conducted. In this research, learning is carried out based on process, content and product. Process differentiation is related to the activities carried out by students in understanding the material being taught. In differentiation the process of integrating student interests into learning. For example, in the learning process they are divided into three groups based on interests, namely drawing, singing, using media in the form of cards. The material studied is Flat Figures. Students are free to express their understanding of flat shapes by drawing flat shapes (drawing group), making flat shapes using origami paper (card media group), and telling about flat shapes directly in their group (singing group). In this way, it has an impact on increasing students' literacy and numeracy skills. This is in accordance with the opinion [29] that by paying attention to the diversity of students' needs, it can increase understanding of the material being studied. Literacy and numeracy are abilities that can be developed through differentiated learning by implementing process, content and product learning strategies. Differentiated learning is an innovation in itself in learning, because differentiated learning is learning that accommodates all the differences that exist in students, is open to everyone and provides the needs required by each individual (Amalia et al., 2023).

Differentiation has a very good connection, one of which is in terms of increasing learning motivation. Students with different characteristics certainly have different learning styles from one to another. Likewise with motivation, one student and another student do not necessarily have the same motivation to learn. To increase students' learning motivation by differentiating learning related to students' interests so that students will enjoy studying the material taught in accordance

with students' interests [31,22]. By understanding student potential, teachers can provide an accurate picture of student strengths and weaknesses, student strengths and weaknesses, and can identify potential that needs to be improved and weaknesses that need to be minimized.

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the differentiated learning activities that have been carried out can improve students' literacy and numeracy skills. This can be seen from the t-test results which show that literacy skills obtained a significance value = 0.04452 and numeracy skills obtained a significance value = 0.000938 with α = 0.05. Based on the test criteria that the significance value <0.05 means that differentiated learning can improve students' literacy and numeracy skills. In addition, the average score of the post-test results on literacy skills is 73.611. While the average score of the post-test results on numeracy skills is 70.277 so that the average result of normalized gain with a literacy ability value of 0.53 and a numeracy ability value of 0.58 means that the increase in ability is included in the moderate category. Although the category is moderate, it shows that there is an increase in students' literacy and numeracy skills after differentiated learning is applied.

Based on the research that has been conducted, it is highly recommended to implement differentiated learning in the classroom as learning that can facilitate student needs. Student needs can include learning readiness, learning interests, and student learning profiles. This is done so that the goals that have been designed can be achieved optimally. Apart from that, differentiated learning can increase teacher competence in managing classes with various student needs. It supports relevant and innovative mathematics teaching. However, there are several things that need to be considered in implementing differentiated learning, namely that it requires quite a long preparation, increasing learning resources and references to facilitate the diversity of student needs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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