EduStream : Journal of Elementary Education

Volume 8, Number 2, 2024
E-ISSN : 2614-4417
Open Access: https://journal.unesa.ac.id/index.php/jpd/index

Differentiated Learning Group Investigation Model to Improve Mathematics Learning Outcomes in Elementary Schools

Latisya Ardi Utami[1*], Fahmi Surya Adikara[2], Esti Susiloningsih[3]
[1,2,3] Elementary School Teacher Education, Faculty of Teacher Training and Education, Universitas Sriwijaya, Indonesia

Corresponding author*: latisyaardiutami@student.unsri.ac.id

ARTICLE INFO

Article history:
Received 17 May 2024
Acccepted 03 November 2024
Published 20 November 2024

Keywords:
Differentiated Learning, Group Investigation, Mathematic Learning

DOI:
10.26740/eds.v8n2.p68-79

ABSTRACT

Mathematics learning in elementary schools often faces challenges that cause students to have difficulties in understanding mathematical concepts which leads to low learning outcomes. This study aims to improve students' mathematics learning outcomes through the application of differentiated learning with *a group investigation model.* The research method used is classroom action research. The data collection techniques used in this study are observation, documentation and tests. The results in this study show that the learning outcomes of Mathematics of mean material have increased significantly. The results of the study prove that differentiated learning can improve Mathematics learning outcomes in elementary schools, especially in mean materials and data presentation. The results of the second cycle mean material mathematics test, students who scored above 70 or were declared complete amounted to 27 people with a percentage of 81.81%. The application of the group investigation model with a differentiated learning approach can be an alternative learning strategy that is effective in improving mathematics learning outcomes. The conclusion of the study is that differentiated learning by applying *the group investigation* model can improve mathematics learning outcomes in elementary schools.

INTRODUCTION

Education is a thing that will always change with the times, meaning that education is not static but dynamic. The Ministry of Education and Culture issued a policy that changed the curriculum to an independent curriculum. In the independent curriculum, teachers are given the freedom to make teaching tools so that they can adjust to the learning needs and interests of students (Moye, 2019; Abdurrohman, 2021; Welch & Aziz, 2023). The independent curriculum is an education that is based on nature and the times, with each student having unique talents and interests. The new curriculum focuses on students and uses the concept of "free learning," which is defined as a strategy that allows students to choose subjects they enjoy. Schools have the right and responsibility to create a curriculum that suits the needs and characteristics of each school (Hasanuddin, 2022; Meliza et al., 2024; Zaeni et al., 2023; Riddle, 2024).

The Independent Curriculum incorporates intracurricular learning so that students have time to learn concepts and strengthen student skills. Although many schools have implemented the independent curriculum, not many teachers understand the independent curriculum and the methods that strengthen the independent curriculum (Farhana, 2023; Suryaman, 2020; Yulianto, 2024). There are still many teachers who transfer knowledge to students by way of lectures so that many students do not understand the material being taught. The independent curriculum requires teachers to be more creative in presenting learning, one of the methods applied lately is differentiated learning. Differentiated learning is a strategy that has been proven successful in improving student learning outcomes. Differentiated learning is a learning approach that varies activities and teaching materials according to students' abilities. This is done systematically to find out academic developments and make data-based decisions (Ardiawan et al., 2024; Mukromin, et al., 2024; Niehues, et al., 2024).

Differentiated learning is a learning model that creates diversity in the classroom based on students' interests, talents and learning styles. With differentiated learning, educators can practice teaching in a more flexible and adaptive setting than previously could. It is becoming increasingly popular due to the fact that this form of teaching is more effective on the work produced by students in the classroom (Kamarulzaman et al., 2022; Moye, 2019; Thapliyal et al., 2022). Differentiated learning is a type of learning that considers the individual characteristics of students and the potential that exists in them (Kamarulzaman et al., 2022; Mukromin et al., 2024; Chen et al., 2024). Teachers must be learning facilitators who are oriented towards meeting the needs of students. Differentiated learning can be applied to subjects in elementary schools, including Mathematics subjects.

Mathematics in Elementary School has 5 areas of material coverage, namely numbers, algebra, measurement, geometry and statistics. Statistics material discusses how to process data. The material focused on this research is in the form of data processing methods, namely mean. Differentiated learning on statistical materials can help improve student learning outcomes, besides that it is important in choosing a model that is applied in learning. The learning model that is suitable for differentiated learning in mean material is the *group investigation type cooperative learning learning model.* In addition, one of the obstacles facing math educators in supporting schools to implement differentiated teaching is the gap between research findings and current school practice. Although there have been significant advances in research aligning different instructions with mathematical reform approaches (Hubbard & Livy, 2021; Makramalla, 2024).

Learning outcomes are changes that are visible after the learning process (Handayani & Subakti, 2020). The group investigation learning model is a method that emphasizes student participation and activities in finding lesson material (information) on their own (Sulistio et al., 2022). The group investigation learning model is a group investigation model, which involves learning steps that require students to understand the problem and plan the lesson. The group investigation *learning model* has advantages such as students are more enthusiastic, active and creative in learning. The group investigation learning model is a learning model that requires students to determine their own topics/sub-topics to be studied as well as the search for material by means of group investigation (Rahmawati & Bektiarso, 2020).

Based on the results of the observations made, students do not understand the material of mean statistics. This can be seen from teaching and learning activities, students are less interested in learning and less active in asking questions when learning takes place. In this study, the

researcher conducted an analysis by interviewing teachers and students regarding mean material. The result obtained is that teachers still teach material using the lecture method without analyzing the needs and learning styles of students. Analysis of the problems that have been revealed, this research is carried out to find a solution to solve the problem of low learning outcomes by applying differentiated learning using *the gorup investigation* learning model.Differentiated learning requires students to be active in learning. This differentiated learning also attracts students' interest in subject matter because they learn the material with their own learning styles. This differentiated learning is also supported by a *group investigation* learning model in a series of lessons, students will search for the data needed in learning, this can increase the active participation of students.

METHOD

The type of research used was classroom action research (Stringer et al., 2009). Classroom action research was a research activity carried out in the classroom and aims to solve teacher learning problems, try new methods to improve learning outcomes and improve the quality and outcomes of learning (Glenn et al., 2023). Researchers were directly involved in these activities. This research process would be carried out based on the Kemmis and McTaggart action research procedures consisting of: (1) planning, (2) action, (3) observation, and (4) reflection.

The teacher planning stage prepared learning tools consisting of teaching materials, worksheets, and assessment tools. Teaching materials were presented according to mathematical concepts that were taught by having special characteristics according to the stages of the *group investigation model*. Preparation for the action stage by compiling learning activity observation instruments and evaluation tools in the form of test questions to measure student learning outcomes. The observation stage was carried out using observation sheets to collect data on student activities during learning activities. After the teaching and learning activities were completed in the first cycle, it ended with learning reflection to determine the actions in the second cycle. The success of the action in this study was according to the criteria in Table 1.

Table 1. Criteria for the Success of the Action

Success Rate (%)	Qualification	Success Actions
85 - 100	Excellent	Succeed
70 - 84	Good	Succeed
55 - 69	Enough	Unsuccessful
40 - 54	Less	Unsuccessful
0 - 39	Very Less	Unsuccessful

If in cycle I the criteria for the success of the minimum action in the good category had been reached, the research was completed, but if the first cycle had not achieved the success of the minimum action in the good category, the research was continued in the next cycle. The data collection techniques used in this study were observation, documentation and tests. This study used qualitative data analysis techniques through the following stages: data reduction, data presentation, and conclusion drawn/*verification*.

RESULT

This research was carried out in two cycles to find out how to improve the learning outcomes of Mathematics students in the sixth grade of elementary school using differentiated

learning group *investigation model*. Based on the research that has been carried out, it is obtained that the improvement of the learning process and results of Mathematics of mean material can be seen in the following diagram. Mathematics learning outcomes of mean material have experienced a significant increase. This proves that differentiated learning using *the group investigation* model can improve Mathematics learning outcomes, especially in mean materials and data presentation. Differentiated learning using *the group investigation* model allows students to learn collaboratively, where they are actively involved in the investigation process and group discussions. This model also provides opportunities for students with various abilities to contribute according to their respective strengths, so that the material can be mastered better. The results obtained show that this approach not only makes learning more interactive, but also significantly improves students' Mathematics learning outcomes, especially in mean materials and data presentation. The group investigation learning model has advantages such as students are more enthusiastic, active and creative in learning.

Teacher activity in the first cycle obtained from observation results was 54.16% with sufficient qualifications and not yet successful. Teachers are not complete in compiling teaching modules, there should be a *diagnostic test* to find out the learning style so that the group is determined based on the teacher's will without looking at the student's learning style, the teacher also does not complete the teaching module with worksheets, which is very important in group discussions so that students know the steps and really understand the purpose of holding the group discussion. Teachers also lack guidance to students in the learning process, especially when students conduct group investigations, so students are confused about what they should do first. The results of these observations are used as material for teacher improvement in the next cycle so that the expected results can be achieved. The results of the first cycle observation are presented in Table 2.

Table 2. Observation Sheet of Teacher Activity Cycle I

Activities	Descriptor	Score
Pre Learning	1. Preparing for teaching modules	3
	2. Preparing media	
	3. Preparing students	
	4. Preparing for class	
Beginning	1. Greeting and wheeling	1
	2. Check student attendance and prepare students to learn	
	3. Convey learning objectives	
	4. Doing aperception	
Core	1. Prepare the necessary media	2
	2. Notify the investigation steps	
	3. Guiding students in investigations	
	4. Providing opportunities for students to ask questions	
GI Model Differentiated Learning	1. Guiding students in completing LKPD	2
	2. Checking student understanding	
	3. Provides advanced exercises or tests	
	4. Presenting in front of the class	
Group Work	1. Form groups and share tasks	3
	2. Providing opportunities for students to ask questions about their tuga	
	3. Providing opportunities for students to use media in each group	
	4. Reward	
Cover	1. Providing opportunities for students to ask questions about the material they have learned and reflect on learning	2
	2. Give the test	

Activities	Descriptor	Score
	3. Guiding students to draw learning conclusions	
	4. Closing the lesson with greetings and prayers	

Teacher activity in cycle II has increased significantly. The percentage of qualifications obtained from the results of observation of teacher activities in cycle II was 91.67% with very good qualifications and declared successful. Teachers improve the shortcomings in the previous cycle so that the expected results can be achieved optimally. Teachers have compiled a complete teaching module accompanied by *diagnostic tests* and worksheets. Teachers have been maximal in guiding students during the learning process, especially investigations. This shows that after conducting evaluations in the previous cycle, teachers are able to correct various existing shortcomings and improve the quality of learning. This improvement is not only seen in the overall learning process, but also in the involvement of teachers in providing guidance to students during the learning process. The results of the second cycle observation are presented in Table 3.

Table 3. Observation Sheet of Teacher Activity Cycle II

Activities	Descriptor	Score
Pre Learning	1. Preparing for teaching modules	3
	2. Preparing media	
	3. Preparing students	
	4. Preparing for class	
Beginning	1. Greeting and wheeling	4
	2. Check student attendance and prepare students to learn	
	3. Convey learning objectives	
	4. Doing aperception	
Core	1. Prepare the necessary media	4
	2. Notify the investigation steps	
	3. Guiding students in investigations	
	4. Providing opportunities for students to ask questions	
GI Model Differentiated Learning	1. Guiding students in completing LKPD	4
	2. Checking student understanding	
	3. Provides advanced exercises or tests	
	4. Presenting in front of the class	
Group Work	1. Form groups and share tasks	3
	2. Providing opportunities for students to ask questions about their tuga	
	3. Providing opportunities for students to use media in each group	
	4. Reward	
Cover	1. Providing opportunities for students to ask questions about the material they have learned and reflect on learning	4
	2. Give the test	
	3. Guiding students to draw learning conclusions	
	4. Closing the lesson with greetings and prayers	

The results of observation of student activities during the learning process in cycle I. The observation includes three important aspects, namely activeness in asking questions, answering teacher questions, and cooperation. The score obtained reflects student involvement in learning activities as well as areas that still need improvement. In the aspect of activeness in asking questions, there is a score of 2 which means that students are indicated to never ask questions due to lack of confidence. This can be a barrier in the learning process because asking questions is one way to understand the material better. In the aspect of answering questions, the teacher

also scored 2, which means that students tend to be passive. Students who do not dare to answer the teacher's questions may have difficulty understanding the lesson. Meanwhile, in the work aspect, it shows a score of 2, which means that students have a tendency to be willing to cooperate but passively. So that overall it shows that student involvement in the learning process is still relatively low with a percentage of 50%. Therefore, it is important to plan appropriate interventions to improve the quality of student interaction during the learning process in the next cycle. The results of the observation of the first cycle of student learning activities are in Table 4.

Table 4. Observation Sheet of Student Activities Cycle I

Aspects Observed	Criterion	Score
Aggressiveness in asking questions	1. Never ask the teacher questions	2
	2. Rarely ask questions to teachers	
	3. Frequently ask questions to teachers	
	4. Actively ask the teacher about the material being studied	
Answering teacher questions	1. Never answered the teacher's questions	2
	2. Rarely answering teachers' questions but not right	
	3. Often answering teachers' questions but not right	
	4. Able to give accurate answers according to the teacher's questions	
Cooperation	1. Want to win by yourself	2
	2. Willing to cooperate but passive	
	3. Want to cooperate but manage people	
	4. Willing to cooperate and respect their friend's opinion	

Student activities in cycle I were declared unsuccessful. This is because the percentage of qualifications obtained from the observation results is only 50% with less qualifications and has not been successful. There are still many students who have not complied with the rules such as still chatting in class. Students are less active and rarely ask questions. Teachers prepare improvement plans for the next cycle and make class rules so that the expected targets can be achieved optimally. Based on the table below, further interventions are needed to improve the learning process both in terms of more careful planning by teachers, such as adding LKPD and diagnostic assessments, as well as providing more guidance in the investigation process. From the student side, it is necessary to increase discipline and motivation to learn so that they are more active in asking questions and participating. The results of the first cycle reflection are in Table 5.

Table 5. Reflection of Cycle I

Teacher Activities	Student Activities	Learning Outcomes
Teachers are not complete in compiling teaching modules that should have LKPD and diagnostic assessments to find out learning styles do not exist so that groups are determined by teachers without looking at students' learning styles	Students do not follow the rules such as still chatting in class	Students are embarrassed when asked to present in front of the class
Teachers lack guidance for students in the learning process, especially during intervention	Students are less active and rarely ask questions	Students still can't solve the problems on the board

Results of observation of student activities during the learning process in cycle II. The observation includes three important aspects, namely activeness in asking questions, answering

teachers' questions, and cooperation. In the aspect of activeness in asking questions, it shows a score of 3, which means that students begin to show initiative by frequently asking questions to the teacher. Although it has not reached the highest level, it has reflected progress compared to cycle 1. In the aspect of answering questions, the teacher also showed a score of 3, meaning that students began to actively answer questions even though the students' answers were not completely correct. Meanwhile, in the aspect of cooperation, it shows a score of 4, which means that students want to work together and respect the opinions of their friends. This increase reflects a positive change in group dynamics in the classroom where students begin to develop social skills and contribute to a better teamwork atmosphere. As shown in Table 6, the results of observation of student learning activities in the second cycle.

Table 6. Observation Sheet of Student Activities Cycle II

Aspects Observed	Criterion	Score
Aggressiveness in asking questions	1. Never ask the teacher questions	3
	2. Rarely ask questions to teachers	
	3. Frequently ask questions to teachers	
	4. Actively ask the teacher about the material being studied	
Answering teacher questions	1. Never answered the teacher's questions	3
	2. Rarely answering teachers' questions but not right	
	3. Often answering teachers' questions but not right	
	4. Able to give accurate answers according to the teacher's questions	
Cooperation	1. Want to win by yourself	4
	2. Willing to cooperate but passive	
	3. Want to cooperate but manage people	
	4. Willing to cooperate and respect their friend's opinion	

Student activities experienced significant changes in cycle II. The percentage of qualifications obtained from the results of observation of student activities in cycle II was 83.33% with good qualifications and was expected to be successful. This is because students are orderly and comply with the rules that have been made. Students also actively ask questions in the implementation of learning. Differentiated learning outcomes using *a group investigation model* to improve the learning outcomes of Mathematics mean material in cycles I and II. The test is carried out to measure student learning outcomes in Mathematics subjects, especially mean materials so that it is expected to be able to improve Mathematics learning outcomes of mean materials. The results of the cycle reflection are in Table 7.

Table 7. Reflection cycle II

Teacher Activities	Student Activities	Learning Outcomes
Teachers have prepared a complete teaching module accompanied by diagnostic assessments and Student Worksheets	Students begin to be orderly and comply with the rules that have been made	Students are brave when asked to make a presentation regarding the results of the discussions that have been carried out
My teacher guides students in the learning process, especially during the invasion	Students actively ask questions in the implementation of learning	Students can do the questions that have been prepared by the teacher

The results of the mathematics test of the mean material of the first cycle, if percentage, are 55.75% with sufficient qualifications. Based on the results of the mathematics test of the first

cycle of mean material, students who scored above 70 or were declared complete amounted to 14 out of 33 students with a percentage of 42.42%. Meanwhile, students who scored below 70 or were declared incomplete were 19 students with a percentage of 57.57%. In Table 8, the results of the Mathematics test of the mean material in the first cycle.

Table 8. Results of the Mathematics Test of Mean Materials Cycle I

Student Name	Number Questions					Total Score	Final Score	Ket.
	1	2	3	4	5			
ADP	1	0	0	1	1	3	60	TT
AW	1	0	0	1	1	3	60	TT
AKR	1	0	0	0	1	2	40	TT
AS	1	1	0	1	1	4	80	T
AA	1	0	0	1	1	3	60	TT
OF	1	0	0	1	0	2	40	TT
AFA	1	0	0	1	0	2	40	TT
ANC	1	0	0	1	0	2	40	TT
BWA	1	0	0	1	1	3	60	TT
BRZ	1	0	0	0	0	1	20	TT
DMF	1	0	1	1	1	4	80	T
DL	1	1	0	1	1	4	80	T
DN	1	0	0	0	0	1	20	TT
GERMAN	1	1	0	1	1	4	80	T
DSP	1	1	0	1	1	1	80	T
IAH	1	0	0	0	0	1	20	TT
JC	1	1	0	1	1	4	80	T
HOOD	1	0	1	1	1	4	80	T
MAFA	1	1	0	1	1	2	80	T
MAR	1	0	0	0	0	1	40	TT
MBA	1	0	0	0	0	1	20	TT
MK	1	1	0	1	1	2	80	T
MR	1	1	0	1	1	4	80	T
BILLION	1	0	0	0	0	1	20	TT
MPY	1	1	0	1	1	4	80	T
MS	1	0	0	0	0	1	20	TT
MJA	1	1	0	1	1	4	80	T
MYP	1	0	0	1	0	2	40	TT
NTA	1	0	0	0	0	1	20	TT
RRAP	1	1	0	1	1	4	80	T
SW	1	1	0	1	1	4	80	T
SAW	1	0	1	1	1	2	80	T
SO	1	0	0	0	0	1	20	TT

Description: TT (Incomplete) and T (Incomplete)

The results of the mathematics test of the mean material of the second cycle, if percentage, are 76.96% with good qualifications and declared successful. Based on the results of the mathematics test of the second cycle of mean material, students who scored above 70 or were declared complete amounted to 27 people with a percentage of 81.81%. Meanwhile, students who scored below 70 or were declared incomplete only amounted to 6 people with a percentage of 18.18%. The learning in cycle II has been successful because it shows good qualifications so that for cycle III it is eliminated. In Table 9, the results of the mathematics test mean material in the first cycle.

Table 9. Results of the Mean Material Learning Test Cycle II

Student Name	Number Questions					Total Score	Final Score	Ket.
	1	2	3	4	5			
ADP	1	1	1	1	1	5	100	T
AW	1	0	1	1	1	4	80	T
AKR	1	1	1	1	1	4	100	T
AS	1	1	0	1	1	4	80	T
AA	1	0	1	1	1	4	80	T
OF	1	0	0	1	1	3	60	TT
AFA	1	1	0	1	1	4	80	T
ANC	1	0	1	1	1	4	80	T
BWA	1	0	1	1	1	4	80	T
BRZ	1	0	0	0	1	2	40	TT
DMF	1	1	1	1	1	5	100	T
DL	1	1	1	1	1	5	100	T
DN	1	0	0	0	0	1	20	TT
GERMAN	1	1	0	1	1	4	80	T
DSP	1	1	1	1	1	5	100	T
IAH	1	0	1	1	1	3	80	T
JC	1	1	0	1	1	4	80	T
HOOD	1	0	1	1	1	4	80	T
MAFA	1	1	0	1	1	2	80	T
MAR	1	0	1	1	1	4	80	T
MBA	1	0	0	1	1	3	60	TT
MK	1	1	0	1	1	2	80	T
MR	1	1	0	1	1	4	80	T
BILLION	1	1	0	1	1	4	80	T
MPY	1	1	0	1	1	4	80	T
MS	1	0	0	1	1	3	60	TT
MJA	1	1	0	1	1	4	80	T
MYP	1	0	1	1	1	4	80	T
NTA	1	0	1	1	1	4	80	T
RRAP	1	1	0	1	1	4	80	T
SW	1	1	0	1	1	4	80	T
SAW	1	0	1	1	1	2	80	T
SO	1	0	0	0	1	2	40	TT

Description: TT (Incomplete) and T (Incomplete)

DISCUSSION

The application of *the group investigation* model has provided opportunities for students in elementary schools to develop the ability to contribute according to individual learning strengths so that the material can be mastered better. The findings obtained show that the differentiated learning approach not only makes learning more interactive, but also significantly improves students' Mathematics learning outcomes, especially in mean materials and data presentation. The findings of the study are in accordance with differentiated learning that uses *the group investigation* model allows students to learn collaboratively, where students can be more actively involved in the investigation process and group discussions (Hubbard & Livy, 2021; Kamarulzaman et al., 2022; Mukromin et al., 2024). The group investigation learning model in this study is proven to have advantages because students are more enthusiastic, active and creative in learning.

Mathematics learning outcomes of mean material have experienced a significant increase. This proves that differentiated learning using *the group investigation model* can improve classroom Mathematics learning outcomes, especially in mean material and data presentation.

This is evidenced by the increase in grades from cycle I to cycle II, where cycle II shows results with good qualifications and is declared successful. The *group investigation* model with a differentiated learning approach can be an effective alternative learning strategy in improving mathematics learning outcomes. This learning also helps students develop collaboration skills and critical thinking skills and improve the classroom atmosphere to be more adaptive to the diverse learning needs of students. The application of the group investigation *learning model* as a model that emphasizes student participation and activities in finding their own lesson material (information). Students play an active role during Mathematics learning in this study because the learning stage as a form of action has provided an opportunity for learning together between students. The activeness of learning Mathematics provides opportunities for students to study seriously so that learning outcomes are optimal (Radišić, 2023; Rijken, & Fraser, 2024).

The group investigation *learning model* is a group investigation model, which involves learning steps that require students to understand the problem and plan its solution. The actions in this study are in a cycle applied with a group investigation *learning model*. This model has been proven to be appropriate for action because it has advantages such as students are more enthusiastic, active and creative in learning. The group investigation learning model is a learning model that requires students to determine their own topics/sub-topics to be studied as well as the search for material by means of group investigation (Rahmawati & Bektiarso, 2020).

CONCLUSION

The results of the mathematics test of the mean material of the first cycle, if percentaged, are 55.75% with sufficient qualifications. Based on the results of the second cycle of the mean material mathematics test, students who scored above 70 or were declared complete totaled 27 people with a percentage of 81.81%. Meanwhile, students who scored below 70 or were declared incomplete only amounted to 6 people with a percentage of 18.18%. Differentiated learning using *the group investigation* model can improve the learning outcomes of Mathematics of mean material. The findings of this study have an impact on the choice of the same action for learning problems found in Mathematics learning in elementary school.

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