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Development of Differentiated Instruction-Based LKS to Improve Grade VIII Students' Understanding of SPLDV Material at SMPN 2 Enrekang

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Abstract

This study aims to develop Student Worksheets (LKS) based on Differentiated Instruction (DI) to improve the understanding of eighth grade students on the material of Two-Variable Linear Equation Systems (SPLDV) at SMPN 2 Enrekang. The method used is research and development (R&D) with the ADDIE model which includes five steps: needs analysis, product design and development, implementation, evaluation, and data analysis. The results of the study indicate that the application of DI-based LKS can improve students' understanding of SPLDV material, as evidenced by a significant increase in pre-test and post-test results. DI-based LKS provides questions with a level of difficulty that is adjusted to the student's abilities, so that each student can learn according to their abilities. Thus, this study suggests the use of DI-based LKS for other mathematics materials as an effort to improve the quality of learning and student learning outcomes.

***Keywords**:* Student Worksheet, Differentiated Instruction, System of Linear Equations in Two Variables, Student Understanding

Introduction

Mathematics education at the junior high school level is a very important stage in building a strong foundation of understanding for students in more complex mathematical concepts. One of the mathematical materials that is often considered a challenge by students is the System of Linear Equations in Two Variables (SPLDV)[1]. This material, which is an integral part of the mathematics curriculum in grade VIII, requires students to understand the relationship between variables and master various methods to solve the equation. SPLDV includes problem-solving techniques such as substitution, elimination, combination and graphical methods, which require analytical skills and in-depth understanding.[2].

However, in practice, many students have difficulty in understanding SPLDV material, especially in two main aspects: first, understanding the concept of relationships between variables in a system of equations; second, students' ability to draw appropriate graphs and use effective solution methods. This indicates that a strong understanding of SPLDV does not only depend on technical skills in solving problems, but also on students' ability to understand the basic principles of the linear equation system itself.[3].

Student Worksheets (LKS) have long been used as a learning aid to improve students' understanding of mathematics

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material. LKS functions to actively involve students in solving problems that are relevant to the material being studied, as well as encouraging students to think critically in finding solutions. LKS that are designed properly can present a variety of problems, according to the level of understanding and learning needs of each student. In this context, Differentiated Instruction (DI) is a very relevant approach to be applied in compiling LKS, especially in SPLDV material.[4].

Based on several previous studies, the development of DI-based LKS has proven effective in improving students' understanding of mathematical concepts. For example, research conducted byThe Last Supper (2020)shows that the application of Differentiated Instruction in mathematics learning can improve students' motivation and learning outcomes. Similar things were found in research showing that the use of LKS that are adjusted to students' abilities can significantly improve students' understanding of mathematics material.[5]. Other research,Solomon (2018),also reported that the implementation of DI-based LKS helped students who previously had difficulty understanding SPLDV material to more easily solve questions with various levels of difficulty.

SPLDV is often considered as quite difficult material for students because it involves a deep understanding of the relationship between variables and skills in manipulating equations. In practice, many students have difficulty understanding the substitution and elimination methods, as well as difficulty in drawing equation graphs correctly. Several previous studies, such as researchSutrisno (2019),shows that the main difficulty of students in SPLDV lies in drawing graphs and understanding the concept of relationships between variables, which is an obstacle in the problem solving process.[6].

Besides that,The Last Supper (2020) found that students with varying abilities tend to benefit more when given an approach that allows them to learn in a way that is more suited to their needs and abilities. This is in line with the principle of Differentiated Instruction (DI), which aims to accommodate differences in ability between students and provide more personalized learning. Therefore, the use of DI-based LKS is very relevant to address this challenge, as it allows learning to be adjusted to the right level of difficulty for each student.[5], [7].

Differentiated Instruction (DI) is a teaching approach that adapts the material, teaching methods, and types of exercises given to students according to their ability level and learning style. This approach aims to provide more personalized and relevant learning for each student, both students with higher abilities and those who need additional guidance. In the context of mathematics learning in grade VIII, DI can be applied by providing practice questions that are appropriate to the level of students' understanding of the Two-Variable Linear Equation System[8].

StudySolomon (2018)revealed that the application of DI in mathematics learning not only improves the understanding of mathematical concepts, but also increases students' motivation and involvement in learning. By using DI-based LKS, teachers can provide questions with varying levels of difficulty, and include instructions that are tailored to students' abilities.[7]. This not only enhances students’ understanding of SPLDV, but also helps them develop critical thinking skills and solve problems in a more efficient manner.

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The DI approach in LKS makes it possible to design questions that vary in form and level of difficulty, which can be adjusted to the learning speed and level of students' understanding.[5]. In addition, DI also provides opportunities for students to choose a solution method that suits their learning style, either through group discussions, visual approaches, or through direct experiments with questions provided in the LKS.

At SMPN 2 Enrekang, the mathematics learning process often faces challenges similar to those found in previous studies. Based on the results of observations and interviews with several mathematics teachers at the school, it was found that SPLDV is one of the materials that is quite difficult to understand for most students.[9]. This is caused by difficulties in drawing equation graphs, a lack of in-depth understanding of the relationship between variables, and a lack of skills in choosing the right method to solve problems.

In addition, students at SMPN 2 Enrekang have varying ability backgrounds, which indicate differences in learning speed and methods. Therefore, the application of Differentiated Instruction (DI) in DI-based LKS is very relevant, because it allows for adjustments to questions that can accommodate the diversity of student abilities. By developing DI-based LKS, it is expected to improve students' understanding of the Two-Variable Linear Equation System, while providing a learning experience that is more in accordance with the needs of each student. Based on a review of the literature and conditions in the field, Differentiated Instruction (DI)-based LKS has great potential to help improve students' understanding of SPLDV material. Previous studies[4], [5], [9]provides strong evidence that DI can improve student learning outcomes, especially in mathematics materials that are considered difficult such as SPLDV. In addition, the application of DI in LKS can provide a more personal and relevant learning experience for each student, accommodate their differences in abilities and needs, and increase student engagement and motivation in learning mathematics.

In practice, Differentiated Instruction (DI) allows teachers to organize learning with high flexibility, so that they can provide learning experiences that are appropriate to the individual needs of students.[10]. One way to implement DI in learning is to compile DI-based LKS, where the questions and instructions given will be adjusted to the students' ability level and learning style. Thus, students who have difficulty in understanding the material can be given simpler and more focused questions, while more advanced students can be given more challenging and more complex questions. This allows students to learn in a way that is more appropriate to their needs, which in turn can improve their understanding of the material being taught.

The use of DI-based LKS in mathematics learning in class VIII not only focuses on various practice questions, but also provides students with the opportunity to choose the best way to solve problems and develop critical thinking skills.[11]. In addition, this approach can also increase student motivation because they feel that the learning provided is relevant to their abilities. Therefore, the development of DI-based LKS for SPLDV material is very important in creating more effective and enjoyable mathematics learning for students.

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By using DI-based LKS, it is expected that students can overcome the challenges they face in understanding the Two-Variable Linear Equation System, and can develop their ability to solve problems more independently and in a structured manner. This study aims to develop DI-based LKS that can be used at SMPN 2 Enrekang, with a focus on improving students' understanding of the SPLDV material. Thus, this study is expected to provide a significant contribution to improving the quality of mathematics learning, especially in the context of SPLDV in junior high schools.

Method

This study uses a research and development (R&D) method with the ADDIE Model. This model consists of five main steps used to develop Student Worksheets (LKS) based on Differentiated Instruction (DI) and test its effectiveness in improving the understanding of grade VIII students on the Two Variable Linear Equation System (SPLDV) material. The following are the steps in developing DI-based LKS carried out in this study[12]:

1. Needs Analysis: In the initial stage, a needs analysis was conducted to understand the characteristics of grade VIII students of SMPN 2 Enrekang, as well as to identify the difficulties faced by students in understanding SPLDV material. The steps taken in this stage include: 1) Student Characteristics Analysis: Identifying the level of student understanding of SPLDV material; 2) Assessing the background knowledge and difficulties faced by students in learning the basic concepts of SPLDV; 3) Identification of Student Difficulties: Using classroom observations, interviews with teachers, and questionnaires to students to find out their difficulties in understanding SPLDV concepts[13].
2. Design and Development of Differentiated Instruction (DI) Based Student Worksheets (LKS) Product (Design and Development): After analyzing the needs, the next step is to design Differentiated Instruction (DI) based Student Worksheets (LKS). These LKS are designed to be adjusted to the students' abilities and learning needs, with several important elements considered in their design: 1) Level of Question Difficulty: The questions in the LKS are designed with varying levels of difficulty, ranging from basic questions for students who need more guidance, to more challenging questions for more advanced students; 2) Type of Questions: The LKS provides various types of questions, such as multiple choice questions, fill-in-the-blank questions, and problem-solving questions that encourage students to learn actively and apply concepts in real life; 3) Directed Instructions: The LKS is equipped with clear instructions, which guide students to work on questions based on their level of understanding, in accordance with the principles of Differentiated Instruction. 4) Initial Testing (Prototype): The LKS prototype that has been designed is tested on a small group of students to measure effectiveness and adjust the product to be more targeted.
3. Implementation of LKS (Implementation): In the implementation stage, the LKS that has been developed is used in the learning process of SPLDV material in class VIII of SMPN 2 Enrekang. The steps in this implementation stage include: 1)

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Implementation of DI-Based LKS in Learning: LKS is used in four learning meetings in one semester. Each meeting focuses on the use of LKS that has been prepared with the principle of Differentiated Instruction; 2) Collaborative-Based Learning: Learning is carried out with an approach that prioritizes collaboration between students in small groups, where they can discuss and help each other in solving problems. 3) Teacher Guidance: The teacher provides guidance according to the instructions in the LKS, ensuring that students work on problems that are in accordance with the level of difficulty and understanding of the students.

4. Evaluation: Evaluation is conducted to measure the effectiveness of the implementation of Differentiated Instruction-based LKS in improving students' understanding of SPLDV material. This evaluation is conducted using various approaches, such as: 1) Pre-Test and Post-Test: Before and after the implementation of LKS, a pre-test and post-test are conducted to measure changes in students' understanding of SPLDV material. The pre-test is given before learning begins to measure students' initial knowledge of SPLDV, while the post-test is given after learning to measure the extent to which their understanding has increased. 2) Classroom Observation: Conducting observations of student participation in class and the use of LKS to determine the effectiveness of LKS in helping students understand SPLDV material. 3) Interviews and Feedback: Collecting feedback from students and teachers to assess how effective DI-based LKS is in improving students' understanding and overcoming the difficulties they face.

Data Analysis. Data collected during the study were analyzed using quantitative and qualitative analysis methods to measure the level of improvement in students' understanding of the SPLDV material. 1) Quantitative Analysis: Data from the pre-test and post-test were analyzed to see the difference in scores between the two and measure the improvement in students' understanding. This analysis was carried out using descriptive statistics to describe the results obtained from the test. 2) Qualitative Analysis: Qualitative data were obtained from classroom observations, interviews, and student feedback to determine the effectiveness of DI-based LKS in overcoming student difficulties.[14]. This study was conducted with 30 eighth grade students at SMPN 2 Enrekang. These students were selected based on their willingness to participate in the study and were divided into several small groups according to their ability to understand the SPLDV material. This group division allows for a more optimal implementation of Differentiated Instruction (DI).

Results And Discussion

This study aims to test the effectiveness of the use of Differentiated Instruction (DI)-based Student Worksheets (LKS) in improving students' understanding of the Two-Variable Linear Equation System (SPLDV) material for grade VIII students at SMPN 2 Enrekang. Based on data obtained from the pre-test and post-test, as well as the results of observations during the learning process, it can be concluded that DI-based LKS has a significant impact on improving students' understanding of the SPLDV material. This study shows that after the implementation

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of DI-based LKS, the average student score has increased significantly.

As part of the quantitative analysis, the researcher measured the increase in students' understanding through pre-tests and post-tests conducted before and after the use of DI-based LKS. Before the implementation of LKS, the average student score on the pre-test was 55, indicating that most students had limited understanding of the SPLDV material. However, after the implementation of DI-based LKS, the average student score on the post-test increased significantly to 80. This increase in score indicates that the use of DI-based LKS contributed directly to improving students' understanding of the concepts and techniques of solving SPLDV problems. These data indicate that most students successfully overcome their difficulties in understanding SPLDV, and more students are able to solve more complex problems well.

Student Understanding Results: In terms of understanding the concept and application of the SPLDV problem solving method, the data obtained showed a very significant increase in the post-test results. Many students previously had difficulty with problem solving techniques using the substitution and elimination methods, but after using the DI-based LKS, students showed significant progress in understanding and applying both methods. Before using the DI-based LKS, many students were unable to draw graphs of two-variable linear equations correctly, or they had difficulty understanding the relationship between variables in the SPLDV. For example, most students had difficulty in determining the intersection points on the graph or could not interpret the graph properly. However, after using the DI-based LKS, students began to be able to draw graphs more accurately, and they also found it easier to understand how the substitution and elimination methods can be applied to find solutions to systems of linear equations.

The Influence of DI-based LKS on Student Understanding

Personalization of Learning. One of the main aspects of Differentiated Instruction (DI) is to provide a personalized learning experience for each student, tailored to the student's ability level and learning needs.[14]. In this case, DI-based LKS provides questions with varying levels of difficulty, allowing each student to work with material that suits their abilities. DI-based LKS provides an opportunity for students to learn according to their level of understanding and ability. Students who have difficulty with the material are given simpler and more focused questions, while more advanced students are challenged with more complex questions. This approach allows students not to feel burdened by questions that are too difficult, and on the other hand, advanced students also do not feel bored with questions that are too easy. A practical example of this personalization of learning is that students who have difficulty drawing graphs are given exercises that focus on basic understanding of graphs, such as recognizing the shape of the graph of a simple linear equation. Meanwhile, students who have mastered this technique are given more in-depth exercises, such as solving SPLDV problems using graphs.

One of the factors that caused the difference in pre-test and post-test results was the difference in initial understanding between students. Before the implementation of DI-based LKS, most students found it difficult to understand the basic concepts of SPLDV and the application of more complex problem-solving techniques, such as substitution and elimination methods. In this study, many students felt confused by the traditional ways of solving SPLDV problems. However, after using DI-based LKS, students began to feel more confident and were able to solve problems correctly, even problems that they previously considered difficult.

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Results of Student Understanding Improvement. The improvement of students' understanding in substitution and elimination methods was very significant after the implementation of DI-based LKS. In the pre-test, only a small number of students were able to apply the substitution and elimination methods correctly, while the majority of students found it difficult. However, in the post-test, most students showed a clear improvement in their understanding of these techniques. They were able to apply both methods more fluently, even on more complex problems. In addition, students who previously could not draw graphs correctly, after the implementation of DI-based LKS, showed significant improvements in drawing graphs of linear equations of two variables. They were able to determine the intersection points more precisely, and were able to interpret the graphs more accurately.

Comparison of Learning Before and After Implementation of DI-based LKS

Before Implementation of DI-based LKS. Before the implementation of DI-based LKS, the majority of students faced difficulties in drawing graphs of linear equations in two variables. They also had difficulties in solving systems of equations using the elimination and substitution methods. Many students did not understand the concept of relationships between variables in SPLDV, which caused their difficulties in solving problems. After Implementation of DI-based LKS. After using DI-based LKS, the majority of students showed very significant improvements. They were not only better able to draw graphs more accurately, but also began to be more confident in using the substitution and elimination methods to solve systems of linear equations in two variables. DI-based LKS allows students to learn according to their level of difficulty, as well as providing a learning experience that is more tailored to each student's needs. More advanced students can tackle more difficult problems, while students who need more guidance get the support they need.

Conclusion

This study aims to develop and test the effectiveness of Differentiated Instruction (DI)-based Student Worksheets (LKS) in improving the understanding of eighth grade students on the material of Two-Variable Linear Equation Systems (SPLDV) at SMPN 2 Enrekang. The results showed a significant increase in student understanding, as evidenced by a better average score on the post-test compared to the pre-test. DI-based LKS allows for personalized learning, where questions are adjusted to students' ability levels, providing challenges for those who are more advanced and supporting students who are struggling. The application of DI has proven to be relevant, making learning more flexible and effective in overcoming student difficulties. Students who previously had difficulty drawing graphs and using substitution and elimination methods can now solve SPLDV problems more easily and accurately. This LKS also encourages students to be more actively involved in the learning process, allowing them to apply concepts in everyday life. Therefore, it is recommended that the application of DI-based LKS be expanded to other learning materials to continue to improve student achievement and understanding in mathematics, as well as provide a fun and relevant learning experience to the needs of each student.

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