The Influence Of The Problem Based Learning Model With Differentiated Learning On Problem Solving Ability

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Abstract. This research aims to compare students' problem-solving abilities in two learning paradigms: one that uses the problem-based learning approach and another that uses standard teaching without differential learning. In 2023–2024, this study was carried out at Budi Agung Medan Private High School. Pretest-Posttest Control Group Design quasi-experimental methodology was employed in this study. The six classes that made up class XI of MIA Budi Agung Medan Private High School were the study's population. The research sample consisted of two XI MIA classes: an experimental class and a control class. According to the study's findings, students who participated in diversified learning had an average score of 71.02 for problem solving skills, compared to 62.73 for students who participated in conventional learning without difference learning. The average difference in problem-solving abilities scores between the control and experimental groups of students was 8.29 points. It was discovered from the hypothesis test results that tcount > ttable, or 2.68 > 1.725. Students' problem-solving abilities are better enhanced when they utilize the problem-based learning model in combination with differentiated learning as opposed to when they rely only on the conventional learning strategy without differentiation. This suggests that Ha is accepted and Ho is rejected.

Keywords: PBL, Differentiation, Problem Solving Ability

1. Introduction

Learning remains mostly teacher-centric, with the expectation that instructors will assist students in comprehending many natural phenomena and daily scenarios, while also fostering critical thinking, analysis, and problem-solving skills, students' problem-solving skills are low[1]. In order to develop reasoning based on observations and data, one must be able to test hypotheses, solve difficult issues, explain mathematical equations by connecting outcomes before and after verifying the hypothesis, and collaborate effectively with others[2].

[1] Palennari, M., Lasmi, L., & Rachmawaty, R. (2021). Keterampilan Pemecahan Masalah Peserta Didik: Studi Kasus di SMA Negeri 1 Wonomulyo. Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi, 5(2), 208–216.

[2] Sitika. (2015). Pengaruh Problem Based Learning (PBL) Berbasis Guided Inquiry (GI) Terhadap Kemampuan Pemecahan Masalah Fisika Ditinjau Dari Kerja Ilmiah. Prosiding Pertemuan Ilmiah, 395–398.

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The results of observations made at SMAS Budi Agung Medan showed that learning activities in the classroom were still teacher-centred. In schools, instruction is implemented mostly through direct instruction from teachers to students, culminating in assignments. Students engage in solving physics problems presented by the instructor; they make conjectures about the formulae used, apply mathematical techniques without thorough investigation, and commit to memory instances of previously solved issues. These tactics have a detrimental effect on student learning results, which do not meet the desired level of proficiency and further undermine students' problem-solving skills. problem.

After analyzing the issues SMAS Budi Agung Medan is facing, efforts must be made to enhance learning models, or learning techniques, which are meant to help students solve challenges and yield the best possible outcomes. Using Based Learning Models is one attempt to enhance learning outcomes and comprehension of physics subjects. Because problem-based learning is student-centered and necessitates knowledge acquisition, the development of thinking skills for problem-solving in an unfamiliar learning environment, by using appropriate educational materials and tools, students' problem-solving skills are significantly enhanced[3][4]. Teachers must be able to differentiate lessons for their students if they want their students to develop problem-solving skills. In essence, each student is unique in terms of their aptitudes, passions, and learning preferences. Differentiated teaching is one educational approach that can address the needs of students with a range of skill levels.

Differentiated learning is a learning framework that takes into account the differences between each student in creating equal learning opportunities[5]. Differentiated learning, the teacher assumes that each individual's way of thinking is different so that he will provide a special way for each student to learn. According to Candra Ditasona's (2017)[6] study shows that compared to children who get standard instruction, those who engage in differentiated learning have more significant improvements in their capacity to solve mathematical problems. Learning that makes use of differential learning strategies by Nur'aini[7] et al (2023), Al-Shehri[8] (2020), Nurasiah[9] et al (2020) and Variaction et al (2021)[10] shows that the applied differentiation

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[3] Zunanda, M., & Sinulingga, K. (2015). Pengaruh Model Pembelajaran Berbasis Masalah Dan Kemampuan Berpikir Kritis Terhadap Keterampilan Pemecahan Masalah Fisika Siswa Smk. Jurnal Pendidikan Fisika, 4(1), 63.

[4] Nasution, U. S. Z., Sahyar, & Sirait, M. (2016). Pengaruh Model Problem Based Learning Dan Kemampuan Berpikir Kritis Terhadap Kemampuan Pemecahan Masalah. Jurnal Pendidikan Fisika, 5(2), 112–117.

[5] Tomlinson, C. A., & Imbeau, M. B. (2010). Leading and managing a differentiated classroom. In Association for Supervision and Curriculum Development.

[6] Ditasona, Candra. (2017). Penerapan Pendekatan Differentiated Instruction dalam Peningkatan Kemampuan Penalaran Matematis Siswa SMA. J.EduMat. Vol.2, no.1. Hal. 43 – 54.

[7] Nur'aini, D. A., Liliawati, W., & Novia, H. (2023). Effect of Differentiated Approach in Inquiry-based Learning on Senior High School Students' Conceptual Understanding of Work and Energy Topic. Jurnal Penelitian Pendidikan IPA, 9(1), 117–125.

[8] Al-Shehri, M. . (2020). Effect of Differentiated Instruction on the Achievement and Development of Critical Thinking Skills among Sixth-Grade Science Students. International Journal Of Learning, Teaching and Educational Research, 19(10), 77–99.

[9] Nurasiah,L., Priatna,B.A., Priatna, N. (2020). The effect of differentiated instruction on student mathematical communication ability. Journal of Physics: Conference Series, 14(69), 50–56.

[10] Variaction,D.A., Salic-Hairulla,M., Bagaloyos, J. (2021). Development of differentiated activities in teaching science: educators' evaluation and selfreflection on differentiation and flexible learning. Journal of Physics: Conference Series, 4(9), 44–54.

learning can have an effect on increasing students' understanding on the learning material studied and its influence on problem solving abilities.

Found that compared to students who did not use differentiated learning, a greater proportion of pupils who did use it achieved the greatest level of knowledge. Students are encouraged to actively engage in solving problems according to their own abilities and learning styles via the use of differentiated teaching and the problem-based learning method. Several studies conducted by Devi et al[11]. (2023) in the context of the problem-based learning paradigm and its implementation of differentiated instruction. Customizing education to match students' unique learning styles within the Problem-Based Learning framework might improve their ability to resolve problems.It is vital to conduct research named "The Influence of the Problem Based Learning Model with Differentiated Learning on Problem Solving Ability" because improving problem solving skills contributes to learning outcomes.

2. Research Methods

This study used a quantitative approach together with research methodologies that were quasi-experimental. Based on these findings, the author concludes that students who participated in problem-based learning-based differentiated instruction outperformed their counterparts who received more conventional instruction when it came to solving problems.

2.1 Time and Place of Research

The research was conducted in Budi Agung Medan Private High School. This research focused on students in the even semester of the 2023–2024 school year who were in Class XI.

2.2 Research Plan/Design

A common research design is the pre- and post-test control group. Before using the problem-based learning approach for differentiating learning, the researcher here ran a pretest on heat and temperature material. Following the implementation of differentiation learning using the problem-solving instructional paradigm, a posttest was given to the subjects of temperature and heat material.

2.3 Population and Sampling Techniques

Class XI students from Budi Agung Medan Private High School, which was divided into 6 classes with 35 students each, made up the study's population. This study's selection strategy made use of already-existing classes, hence the sample was not selected at random. in which XI-1 is the experimental class and XI-2 is the control class.

2.4 Data Collection Techniques and Tools

The test procedure is the method utilized to collect data. The method of testing is an ability to solve problems. This study's test methodology involves a problem-solving ability test with five descriptive question types. The choice of a description-based test was made since it allows for the observation of the student's methodical approach to solving physics problems. The following questions can be used to gauge a person's ability to solve problems: (1)

[11] Devi,AN., Hera,N., Winny, L. (2023). The Effect of Differentiated Approach in Inquiry-based Learning on Senior High School Students' Conceptual Understanding of Work and Energy Topic. Journal of Research in Science Education, 9(3), 117–125.

comprehending the problem; (2) interpreting the problem; (3) planning a strategy; (4) putting the strategy into action; and (5) assessing the outcome[12].

2.5 Data Processing (Analysis) Techniques

In this research, differentiation learning is considered as the independent variable (X), while problem-solving abilities are regarded as the dependent variable (Y). Two groups, one experimental and one control, were included in this investigation. Students in the experimental group were exposed to problem-based learning and differentiated instruction, while those in the control group received more conventional instruction.

The procedure begins with an initial analytical test and ends with an idea test. Two parametric statistics tests that are part of the precondition analysis test procedure are the variance homogeneity test and the normality test. Prior to moving further with the analysis at hand, it is essential to do the homogeneity and normality tests. The research hypothesis will be assessed using the t-test in a comparison hypothesis test for two samples once the normality and homogeneity of the data have been established. Hypothesis testing is carried out to find out whether the hypothesis proposed in this research is accepted or rejected. To test the difference in posttest averages, a right-hand test is used with the following hypothesis formulation:

$$\text{Ho} : \mu_1 \leq \mu_2 \quad (1)$$

$$\text{Ha} : \mu_1 > \mu_2 \quad (2)$$

Or it can be stated as follows:

Ho: The average problem solving ability of students who take part in differentiation learning using the problem based learning model is lower than students who take part in conventional learning.

Ha: The average problem solving ability of students who take part in differentiated learning using the problem based learning model is higher than students who take part in conventional learning.

The t-test formula used to test the comparative hypothesis of two uncorrelated samples according to Sugiyono[13] (2018: 273) is shown in the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} \quad (3)$$

After the price is obtained, it is then compared with the test criteria for areas of acceptance and rejection of the hypothesis which are as follows;

- Reject Ho and accept Ha, if: tcount > ttable
- Accept Ho and reject Ha, if: tcount ≤ ttable

The hope in this posttest average difference test is to reject H0 and accept Ha.

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[12] Heller,P., Keith,R., Anderson, S. (1991). Teaching Problem Solving Through Cooperative Grouping. Part 1: Group Versus Individual Problem Solving. American Journal of Physics, 10(60), 627–636.

[13] Sugiyono. (2018). Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D. Bandung: Penerbit Alfabeta.

2.6 Research Procedure

The research process consisted of three primary phases that were used to gather and acquire the data required for this study. These three phases are the data analysis stage, the execution stage, and the preparation stage. It will be clarified as follows for further information:

1. Preparation Stage

   Some of the activities carried out in connection with preparation for conducting research are as follows:

   a. Prepare a letter of approval from the supervisor
   b. Identify the issue, name, place, and schedule of the investigation
   c. Identify both the population & sample
   d. Analysis preparation is carried out through stages of making preparations that support the research process, namely compiling research instruments in the form of grids and test instruments, making learning plans.
   e. Manage research permits.
   f. Met the principal of Budi Agung Medan Private High School to ask for permission to carry out research.
   g. Consult with the physics teacher to determine the time and technical implementation of the research, Choosing a sample consisting of two classes, one to serve as a control group and the other as an experimental group.
   h. Carrying out content validity and construct validity
   i. Process validation data.

2. Implementation Stage

   The second phase of this study involves the use of differentiated instruction using a problem-based learning approach, with the researcher serving as the instructor. This research was carried out in the following sequence:

   a. Providing a pretest of students' problem solving abilities, namely the experimental class (XI-1) and the control class (XI-2)
   b. Conducting educational activities for the experimental group involves implementing differentiated learning by employing a problem-based learning approach, while the controls group follows traditional teaching methods.
   c. Following the examination of temperature and heat material, both the experimental class and the control class had a posttest to assess their problem-solving skills. The objective is to ascertain the disparities in the capabilities of each study group after the administration of distinct interventions.

3. Data Processing Stage

   The data processing stages (final stages) in this research are as follows:

   a. Collect data from each class.
   b. Carry out data analysis, namely normality and homogeneity tests
   c. Test the hypothesis using the t-test.
   d. Make conclusions.

3. Result and Discussion

The data in this research is derived from an assessment of the problem-solving abilities of students in the eleventh grade at Budi Agung Medan Private High School. Following the collection of data, data analysis is done on the connected experimental class problem-solving ability score data as well as the control class problem-solving ability scores. Following is a display of the data derived from the final calculation results of the pre- and post-learning evaluations of the problem-solving skills

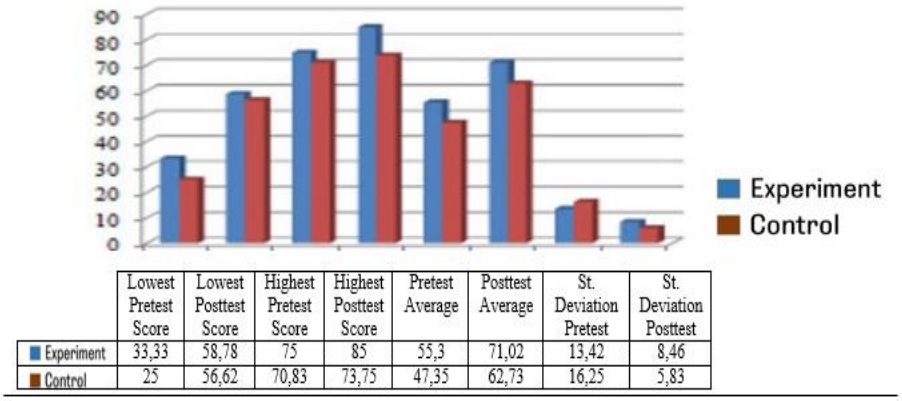
Table 1. Description of Pretest and Posttest Students' Problem Solving Abilities

Mark	Experiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
N	35	35	35	35
Lowest	33,33	60	25	56,25
Highest	75	85	70,83	73,75
Average	55,30	71,02	47,35	62,73
St.Deviasi	13,42	8,46	16,25	5,83

Table 1 shows that there are 35 students in the control group and 35 in the experimental group. Pretest scores in the experimental group ranged from 33.33 to 75, with no student achieving a score below 75. The standard deviation was 13.42, and the mean score was 55.30. Pretest scores for the control group children ranged from 25 (lowest) to 70.83 (highest), with 47.35 (average) and 16.25 (standard deviation) observed.

Within the experimental class, students' average posttest score was 71.02, their maximum posttest score was 85, their lowest posttest score was 60, and their posttest standard deviation was 8.46. The control class had kids with average posttest scores of 62.73, greatest and lowest posttest scores of 56.25 and 73.75, as well as a posttest standard deviation of 5.83.

The data from the pretest and posttest pertaining to the problem-solving abilities of students in the experimental class and the control class are illustrated in Figure 1:



	Lowest Pretest Score	Lowest Posttest Score	Highest Pretest Score	Highest Posttest Score	Pretest Average	Posttest Average	St. Deviation Pretest	St. Deviation Posttest
Experiment	33,33	58,78	75	85	55,3	71,02	13,42	8,46
Control	25	56,62	70,83	73,75	47,35	62,73	16,25	5,83

Fig. 1. Description of Pretest and Posttest Data on Students' Problem Solving Ability

Descriptively, there are several conclusions that can be seen from students' solving abilities from Figure 1, namely:

1. The average pretest score for problem-solving aptitude among students in the experimental group was 55.30, which was higher than the average pretest score of 47.35 for students in the control group.
2. In the experimental group, the average posttest score for problem-solving proficiency among students was 71.02, which was higher than the mean posttest score of 62.73 in the control group.

The data is known to be normally and homogeneously distributed based on the findings of the homogeneity and normality tests. According to learning style data obtained using the "Aku Pintar" application (akupintar.id), 45 students are classified as having a visual learning style, 15 as having an auditory learning style, and 10 as having a kinesthetic learning style. These results indicate that, in comparison to auditory and kinesthetic learning methods, 45 students have stronger visual learning preferences.

Hypothesis Test

Hypothesis testing uses the right-hand t-test. Hypothesis testing is carried out to determine the conclusions of the research. The following is data from the analysis of hypothesis testing (t-test) of students' problem solving abilities.

Table 2. Hypothesis Test Results (t-test) Students' Problem Solving Ability

Class	t_{count}	t_{tabel}	Conclusion
Experiment Control	2,68	1,725	H_a accept

Table 2 shows that the ttable derived from the t distribution data for $\propto = 0.05$ (one-party test). Given the values of tcount = 2.68 and ttable = 1.725, it is possible to conclude that Ho is rejected while Ha is accepted when tcount > ttable, or 2.68 > 1.725. Thus, it can be said that students who participate in diversified learning have a greater gain in their problem-solving skills than students who participate in traditional learning.

Summary

The conclusion was derived from the results of a research done at Budi Agung Medan Private High School, which investigated the efficacy of differentiated instruction using the problem-based education paradigm to improve the problem-solving abilities of students. More precisely, the mean score for problem-solving skills among students in the experimental class was 71.02, which is the same as the general average scoreThe control group exhibits a solving issues proficiency of merely 62.73 percent. The mean score on problem solving for the experimental class deviated from that of the control class by a margin of 8.29 points. Based on the hypothesis test results, which are tcount = 2.68 and ttable = 1.725, it may be concluded that tcount > ttable, or 2.68 > 1.725. This suggests that Ha has been validated while Ho has been rejected, showing that students who engage in differentiated learning using the problem-based learning approach have shown more improvement in their problem-solving abilities compared to those who pursue conventional learning programs.

References

[1] Palennari, M., Lasmi, L., & Rachmawaty, R. (2021). Keterampilan Pemecahan Masalah Peserta Didik: Studi Kasus di SMA Negeri 1 Wonomulyo. Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi, 5(2), 208–216.

[2] Sitika. (2015). Pengaruh Problem Based Learning (PBL) Berbasis Guided Inquiry (GI) Terhadap Kemampuan Pemecahan Masalah Fisika Ditinjau Dari Kerja Ilmiah. Prosiding Pertemuan Ilmiah, 395–398.

[3] Zunanda, M., & Sinulingga, K. (2015). Pengaruh Model Pembelajaran Berbasis Masalah Dan Kemampuan Berpikir Kritis Terhadap Keterampilan Pemecahan Masalah Fisika Siswa Smk. Jurnal Pendidikan Fisika, 4(1), 63.

[4] Nasution, U. S. Z., Sahyar, & Sirait, M. (2016). Pengaruh Model Problem Based Learning Dan Kemampuan Berpikir Kritis Terhadap Kemampuan Pemecahan Masalah. Jurnal Pendidikan Fisika, 5(2), 112–117.

[5] Tomlinson, C. A., & Imbeau, M. B. (2010). Leading and managing a differentiated classroom. In Association for Supervision and Curriculum Development.

[6] Ditasona, Candra. (2017). Penerapan Pendekatan Differentiated Instruction dalam Peningkatan Kemampuan Penalaran Matematis Siswa SMA. J.EduMat. Vol.2, no.1. Hal. 43 – 54.

[7] Nur'aini, D. A., Liliawati, W., & Novia, H. (2023). Effect of Differentiated Approach in Inquiry-based Learning on Senior High School Students' Conceptual Understanding of Work and Energy Topic. Jurnal Penelitian Pendidikan IPA, 9(1), 117–125.

[8] Al-Shehri, M. . (2020). Effect of Differentiated Instruction on the Achievement and Development of Critical Thinking Skills among Sixth-Grade Science Students. International Journal Of Learning, Teaching and Educational Research, 19(10), 77–99.

[9] Nurasiah,L., Priatna,B.A., Priatna, N. (2020). The effect of differentiated instruction on student mathematical communication ability. Journal of Physics: Conference Series, 14(69), 50–56.

[10] Variaction,D.A., Salic-Hairulla,M., Bagaloyos, J. (2021). Development of differentiated activities in teaching science: educators' evaluation and selfreflection on differentiation and flexible learning. Journal of Physics: Conference Series, 4(9), 44–54.

[11] Devi,AN., Hera,N., Winny, L. (2023). The Effect of Differentiated Approach in Inquiry-based Learning on Senior High School Students' Conceptual Understanding of Work and Energy Topic. Journal of Research in Science Education, 9(3), 117–125.

[12] Heller,P., Keith,R., Anderson, S. (1991). Teaching Problem Solving Through Cooperative Grouping. Part 1: Group Versus Individual Problem Solving. American Journal of Physics, 10(60), 627–636.

[13] Sugiyono. (2018). Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, dan R&D. Bandung: Penerbit Alfabeta.