JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

The Effect of Problem Based Learning Model and Differentiation Approach on the Results of Natural and Social Science Learning of Grade V Students

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Received: December 20, 2024
Revised: February 21, 2025
Accepted: April 25, 2025
Published: April 30, 2025

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DOI: 10.29303/jppipa.v11i4.10935

Abstract: This study examines the impact of the problem-based learning model and differentiated approach on the learning outcomes of natural and social science students in grade V at SD Mahesa Jenar Cluster, Ambarawa District, Semarang Regency. Interviews and observations revealed that students learning outcomes remain low due to monotonous, teacher-centered learning models that do not address student's needs. The problem-based learning model enhances critical thinking, while the differentiated approach caters to individual students needs. Both methods are student-centered, aiding learners in understanding concepts and applying them in real life. Employing a quantitative ex post facto design, data were collected through questionnaires distributed to students. The variables studied include natural and social science learning outcomes (Y), problem-based learning models (X1), and differentiated approaches (X2). Data were tested for normality, linearity, multicollinearity, and heteroscedasticity before analysis. Hypothesis testing utilized simple correlation, multiple correlation, simple regression, multiple regression, determination tests, and F-tests. Results indicated that the problem-based learning model influenced learning outcomes by 4% (R square = 0.040), while the differentiated approach contributed 3.7% (R square = 0.037). combined, these approaches had a joint influence of 6.3% (R square = 0.063), positively affecting students learning outcomes in grade V at SD Mahesa Jenar Cluster, Ambarawa District, Semarang Regency.

Keywords: Differentiated; IPAS; Learning outcomes; Problem-based learning

Introduction

Educations a foundation in human life. With education, the level of progress of a nation can be seen clearly, because education plays a major role in the progress of a nation. As noted by Saputra et al. (2021), education serves as a nurturing environment where individuals grow and develop, empowering them to reach their full potential and facilitating the transformative process that occurs from one generation to the next. Education that has high quality will produce or create something new that is creative and innovative. In recent decades, education has experienced mostly modest, incremental improvements, including enhancements to classroom environments, updates to curricula, and the development of libraries and other essential infrastructure, Gleason (Qorib, 2024). Elementary school is the initial stage in children's development, because this is where the foundation of their knowledge, skills, and attitudes is formed. This is in line with the objectives stipulated in Law Number 20 of 2003 Chapter II Article 3 concerning the National Education System. This Law emphasizes that the purpose of national Education is to foster and develop

How to Cite:
Amalia, L., & Ratnaningrum, I. The Effect of Problem Based Learning Model and Differentiation Approach on the Results of Natural and Social Science Learning of Grade V Students. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 81-93. https://doi.org/10.29303/jppipa.v11i4.10935

students so that they have the values of Pancasila. These values cover six dimensions: faith in God Almighty, noble morals, independence, mutual cooperation, respect for global diversity, and the ability to think critically and creatively. The individual needs of each student are carefully considered, enabling them to learn and grow beyond the expected norms (Taylor, 2017). Education serves the purpose of guiding the growth and development of students' innate abilities, focusing on enhancing their behavior rather than altering their fundamental nature. Through the learning process, education promotes self-awareness and self-control, enabling students to recognize and understand the patterns of their personal qualities. This, in turn, helps them strive for self-realization (Anggraini & Wiryanto, 2022).

As education lays the groundwork for individual growth and societal progress, the urgent need to enhance the quality of learning in elementary schools becomes evident, particularly in subjects like Natural and Social Sciences (IPAS), which are essential for developing students' understanding of their environment. In the midst of the dynamics of the development of education, efforts to improve the quality of learning in elementary schools are an urgent need. One of the main challenges faced is the relationship between students and their knowledge and environment. In this context, the main focus is to improve students' learning outcomes, especially in the Natural and Social Sciences (IPAS) subjects, which are deeply related to individuals and their environment. Learning outcomes reflect the skills that have been developed by students after completing their educational journey. In addition, learning outcomes can also be interpreted as the knowledge and skills acquired by students during a certain learning period. Learning outcomes refer to the skills that students acquire as a result of their engagement in the educational process. These outcomes encompass cognitive, affective, and psychomotor skills, as noted by Fridayanthi (Hapsari et al., 2022). This also serves as an indicator to assess students' understanding during the learning process (Mudanta et al, 2020).

Given the urgent need to enhance learning quality in elementary schools, particularly in the Natural and Social Sciences (IPAS), it is essential to recognize how these subjects not only engage students through their relevance to personal experiences but also foster critical thinking and collaborative skills necessary for navigating their environments. Natural and Social Sciences (IPAS) attract students' interest because of its direct connection to personal experiences and the surrounding environment. This subject is not only limited to the memorization process, but also encourages a deep understanding of concepts through active learning. The process involves various activities such as observation, discovery, and presentation of complex data. Learning natural and social sciences is intended to equip students with high-level thinking skills. This ability will be useful for developing students' potential to follow the changes that are taking place. Thus, to see the quality of education can be measured through the ongoing learning process. This learning is the result of collaboration between educators and students, where both work together to achieve the expected academic goals. The success of this process can ultimately be evaluated through the assessment of student learning outcomes. Success in learning is measured by the extent to which students are able to understand and master the material taught during the learning process, (Salam, 2019).

While the Natural and Social Sciences (IPAS) engage students through their relevance to personal experiences and promote high-level thinking skills, achieving effective learning outcomes requires careful consideration of diverse student needs and the implementation of effective teaching strategies. Objective learning includes mastery of knowledge, skills, and development of attitudes that are crucial for students to be able to carry out certain tasks and roles effectively, according to predetermined criteria, Richey (Sitorus et al., 2023). In every classroom, students possess a diverse range of prior knowledge, backgrounds, learning styles, needs, preferences, and interests (Al-Shehri, 2020). Several factors can influence learning goals and outcomes, starting from the initial design before the learning process takes place. Elements such as learning models, materials, and media used by educators play a very important role in improving students' academic outcomes and helping to achieve the desired learning goals (Suryani et al., 2023). The first thing an educator must do before carrying out learning is to prepare a learning plan, educators need to find the most effective strategy to support the learning process. Learning strategies can be likened to a clear action plan, describing the use of methods and resources that will be utilized during the learning process, Sani (Sitorus et al., 2023). Moreover, teachers can foster connections that empower students to solve problems more effectively, think critically, and engage more actively in their own learning process (Memduhoğlu & Keleş, 2016). The selection of this strategy can be started with the selection of learning methods, learning models, and approaches during learning.

While the focus on objective learning emphasizes the mastery of knowledge and skills tailored to diverse student needs, implementing differentiated learning strategies further enhances educational effectiveness by

accommodating individual learning styles and fostering an inclusive classroom environment. Differentiated teaching positively influences both teachers and students (Sofiyana et al., 2024). The differentiation was selected to enhance the cooperation among learners in the learning process (Nestiyarum & Widjajanti, 2023). Differentiated learning is an approach designed to address the diverse needs of students by tailoring instruction to their individual readiness, interests, and learning styles. When selecting solutions for a differentiated approach, it is important to consider adaptations that align with students' interests, learning profiles, and their motivation to achieve higher learning outcomes (Maryanti & Sartono, 2024). Differentiated learning is an effective educational approach that recognizes the unique characteristics of each student. By tailoring instruction to accommodate their willingness, interests, and individual learning profiles, it seeks to enhance each student's potential (Dalila et al., 2022). This strategy aims to optimize learning outcomes for all students (Qorib, 2024). Differentiated teaching represents a novel perspective on instructional practice that influences various aspects of education. It impacts teachers' approaches to teaching, student learning, classroom management, time allocation, curriculum delivery, and the assessment of student work (Sakellariou et al., 2018). A fundamental concept of this theory is that learners are inherently diverse, varying in characteristics, tendencies, home environments, prior knowledge, and learning styles. Each student possesses a unique mindset, which influences how they learn and when they do so. Furthermore, the theory offers various methods, procedures, and activities designed to help each student reach their individual goals using suitable approaches and tools. It also fosters a learning environment that accommodates the needs of all learners (Onyishi & Sefotho, 2020). This aims to help students avoid frustration and prevent them from struggling in their learning journey (Patilima et al., 2025). The use of differentiated teaching strategies particularly benefits students with special needs, resulting in positive outcomes for all children, as well as for parents and society as a whole (Morina, 2019). Differentiated teaching emphasizes the incorporation of contemporary educational techniques by diversifying instructional methods. This approach aims to support all students, regardless of their varying skill levels, in reaching their highest potential and achieving excellence (Smadi & Al Masri, 2018). Smale-Jacobse et al. (2019) conducted a systematic review of the literature exploring the potential advantages of differentiated instruction. It has been observed that contemporary classrooms tend to be quite diverse, comprising students from various cultural and linguistic backgrounds.

While differentiated learning strategies are essential for addressing the diverse needs of students and enhancing their educational experiences, effective implementation of these strategies further empowers teachers to deliver meaningful instruction that fosters individual growth and maximizes learning outcomes. Differentiation doesn't necessarily need to cater to the needs of every learner all the time. Nevertheless, teachers are expected to employ a range of instructional strategies to ensure that the majority of students can engage with the material in a way that suits their individual needs (Susanti et al., 2023). Differentiation serves as an effective approach for teachers to deliver meaningful instruction on challenging content. By tailoring their teaching to meet students' individual needs and levels, educators can facilitate maximum growth in their learners (Tyrou et al., 2023). As teachers become more comfortable implementing differentiation in the classroom, the positive effects on their students increase significantly (Bogen et al., 2019). Teachers should proactively support and encourage their students in the learning process, while also considering each student's preferred learning style (Al-Shehri, 2020). Effective and differentiated teaching positively impacts students' academic performance, benefiting all learners, including those with learning differences, (Valiandes & Neophytou, 2018). Teaching is viewed as a multifaceted problem-solving process that involves conveying the right values, skills, and knowledge between at least two individuals: the teacher and the learner (Adeniji et al., 2018). Departing from the principle of differentiated learning in science learning where each individual student has their own characteristics in solving problems. These variations in characteristics may manifest as differences in skills, experiences, talents, interests, languages, cultures, and learning styles, collectively referred to as student diversity (Musdahlipah et al., 2024). Differentiated teaching in heterogeneous classrooms enhances students' preparedness for real-life situations. It fosters the development of new roles and relationships, leading to learning experiences that are personally meaningful, transferable, and sustainable (Haelermans, 2022). Thus, it is hoped that the educational approach used will consider the various abilities of students in solving problems. That way, students' problem-solving abilities can develop according to needs (Nawati et al., 2023).

While differentiated learning effectively addresses the diverse needs of students and enhances their engagement in the learning process, integrating Problem-Based Learning (PBL) strategies further enriches this approach by fostering critical thinking and collaboration, ultimately leading to deeper understanding and application of knowledge. Zuryanty

et al. (2019) indicated that utilizing Problem-Based Learning (PBL) strategies is an effective approach for enhancing primary school students' thinking skills in science education. Contemporary science education prioritizes engaging students in the learning process by encouraging active exploration (Verawati et al., 2023). Problem-Based Learning (PBL) utilizes constructivist principles to foster the use of prior knowledge, encourage collaborative learning, and enhance active engagement (Seibert, 2021). A PBL (Problem-Based Learning) challenge serves effectively as a catalyst for initiating the learning process. Unlike traditional problems, PBL challenges typically do not have a single, definitive solution; instead, they require thorough exploration and explanation rather than simple resolution (Wijnia et al., 2019). The problem-based learning model is an effective learning model in accommodating various thinking styles and can be integrated with various approaches including differentiated approaches. Learning models like problem-based learning (PBL) have proven to be effective tools for fostering critical thinking, collaboration, and innovative problem-solving among students (Nafizatunni'am et al., 2024). In this model, the learning process begins by giving students a number of specific problems that they need to solve. In practice, problem-based learning (PBL) is utilized within the education system to address and explore real-world problems (Orozco & Yangco, 2016). In a Problem-Based Learning (PBL) activity, the issue at hand should reflect a common, work-related challenge or scenario characterized by incomplete information or ambiguous solutions. This resembles the characteristics of poorly structured case studies (Miner-Romanoff et al., 2019). Rudini (2020) problem-based learning model (PBL) is a learning approach where students interact with real or authentic problems. Students are encouraged to define the problem independently and find relevant materials needed to solve it. PBL is an educational model that allows students greater freedom to explore topics they find particularly relevant (Krupat et al., 2016). This model offers students the chance to tackle problems rooted in their own experiences, fostering an environment that encourages and inspires learning. By building upon students' ideas, it promotes deeper engagement and understanding (Yasmini, 2022).

While the Problem-Based Learning (PBL) model emphasizes the teacher's role as a facilitator to enhance critical thinking and problem-solving skills among students, its successful implementation relies on understanding diverse student needs and integrating effective instructional strategies that foster engagement and collaboration. At PBL, the teacher assumes the role of a facilitator instead of simply delivering lectures. In this capacity, the facilitator acts more like a coach or guide, offering valuable feedback and encouragement to students (Salari et al., 2018). Teachers can enhance the efficiency of their instruction by integrating their students' thinking styles, provided they are familiar with their cognitive abilities (Heong et al., 2020). With active involvement in this process, the problem-based learning model is able to foster critical thinking skills while improving students' ability to develop rational solutions. The PBL paradigm emphasizes topics that enhance students' skills, including their cognitive abilities and critical thinking skills (Amin et al., 2020). Important aspect is that implementing Problem-Based Learning (PBL) can enhance students' critical thinking skills. This finding aligns with (Nawati et al., 2023), which concluded that the use of the PBL model significantly boosts students' grasp of concepts and their ability to think critically. Septikasari et al. (2018) emphasize that children need to develop the 4Cs—critical thinking, creativity, collaboration, and communication. Problem-based learning fosters the development of soft skills in students; however, it is essential to implement suitable assessments to effectively measure these skills (Ulfa & Rosidin, 2024). To effectively prepare for the skills required in the 21st century, it is essential for all stakeholders, especially schools, to actively participate in this endeavor. This aligns with the principles of 21st-century education, which prioritizes a student-centered approach to learning, fostering more innovative and creative teaching and learning experiences (Nahar et al., 2021). Recently, Zhou (2018) conducted a study examining the impact of Problem-Based Learning (PBL) on the critical thinking skills of nursing students. The findings revealed that PBL significantly enhanced their abilities in analysis and interpretation, key components of critical thinking. Utilizing the problem-based learning model can greatly enhance student learning outcomes (Zulkifli et al., 2023).

Based on the implementation of interviews and observations of researchers on fifth grade educators at SD Se-Gugus Mahesa Jenar located in Ambarawa District, Semarang Regency, in the learning process, educators have not focused on students and have not fully adjusted to the needs of students. The models used during learning are still monotonous for learning models such as the problem-based learning model which is still rarely implemented. In addition, educators have not fully adjusted the learning styles, interests, or needs of students during learning. With the low use of appropriate models and approaches, students have difficulty understanding the material, often feel bored, do not play an active role, and have difficulty developing their potential. As a result, students often

have difficulty in achieving their full potential which results in the Learning Objective Achievement Criteria (KKTP) also not being met.

Based on the background above, researchers are interested in conducting research with the title The Effect of the Problem-Based Learning Model and Differentiated Approach on the Learning Outcomes of Natural and Social Science Students in Grade V. Thus, the researcher chose the variables of problem-based learning model and differentiated approach, because problem-based learning improves critical thinking and is also supported by different approaches that meet students' needs. Both variables are student-centered so they can help students understand concepts and apply them in real life, and are also supported by different approaches. This research presents a fresh perspective by examining how to effectively combine project-based learning (PBL) with differentiated strategies to meet the diverse needs of students and enhance their learning outcomes. PBL is centered on engaging students through active participation and solving real-world problems, while differentiation focuses on customizing content, processes, and products to align with individual abilities, interests, and readiness levels. By integrating these two approaches, we can create an inclusive learning environment that promotes critical thinking, creativity, and collaboration—all of which are essential in today's increasingly diverse classrooms. So, this study examines the impact of the problem-based learning model and differentiated approach on the learning outcomes of natural and social science in grade V students.

Method

This study applies a quantitative method referring to Sugiyono (Fadilah & Sapari, 2020), quantitative research is rooted in the philosophy of positivism and aims to investigate a particular population or sample. In this context, the ex post facto design is applied to identify the causes behind changes in behavior, symptoms, or phenomena that are influenced by events, actions, or factors that occurred previously on various independent variables. According to Arikunto in Maisarah et al. (2022), ex post facto research examines variables where the facts or events have occurred before the research was conducted. Ex post facto can also be used to make predictions based on existing data. This study aims to analyze and describe the effect of the problem-based learning model and the differentiated approach on learning outcomes in natural and social science subjects in grade V at SD Se-Gugus Mahesa Jenar, Ambarawa District, Semarang Regency. The ex post facto method is well-suited for examining how problem-based learning models and differentiated approaches impact student learning outcomes. This approach enables researchers to analyze existing characteristics and effects without the need to manipulate variables, making it both ethically sound and practically advantageous in educational settings. In this study, the total population involved consisted of 143 students, where the final sample of 106 students was selected through the probability sampling technique, namely the simple random sampling type and using the Slovin formula with an error rate of 5%.

This study adopted a data collection method that combines unstructured interviews, documentation, and closed questionnaires using a 4-point Likert scale to obtain data. In this study, the initial step involved conducting unstructured interviews with each fifth-grade teacher at Gugus Mahesa Jenar elementary school. Unstructured interviews were conducted to explore the challenges faced by elementary schools in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency. In addition, documentation was used to collect Semester Summative (SAS) scores in the Social Sciences subject at the end of the first semester. Data was collected through questionnaires that were distributed among the students. The questionnaire 4-point Likert scale was designed to assess the implementation of problem-based learning models and differentiated approaches. This questionnaire was carefully designed based on certain indicators corresponding to each variable under investigation, arranged in the form of a grid, and then converted into a number of statement items for survey purposes.

Before being used in research, the questionnaire instrument that has been prepared needs to be tested first. According to Sugiyono in Pujianto et al. (2020), a trial of the questionnaire that has been prepared needs to be carried out on around 30 students outside the sample but still in the same population to determine the validity and reliability of the questionnaire. Testing is carried out to determine whether the questionnaire instrument is suitable to be given to respondents. Testing the instrument is called a validity test and a reliability test. In testing the validity of a research instrument, it is very important to consider both aspects, namely internal and external validity. In this study, the assessment of internal validity was carried out by a team of experts, namely Mrs. Ika Ratnaningrum, S.Pd., M.Pd who acted as the thesis supervisor and Mrs. Reni Indriyani, S.Pd as a grade V elementary school educator. Internal validity is ensured by completing a validity sheet that encompasses each instrument evaluated in the research questionnaire. After the experts assessed the instrument, a trial sample was taken from the population sample to continue the analysis.

Furthermore, external validity test was conducted using SPSS version 22 analysis to analyze the questionnaire scores collected from the students. The Item-Total Statistics output obtained from the statistical analysis showing the results of the validity test is in the Corrected Item-total Correlation column. Based on these results, there are statements that are considered valid and some are not. From the problem-based learning model trial questionnaire consisting of 40 statements, 22 statements were successfully validated. Likewise with the differentiated approach test questionnaire which also contains 40 statements, of which 35 statements are valid. A statement item is considered valid if its correlation coefficient exceeds the specified critical value rcount ≥ rtable, rtable, which in this study was set at 0.361.

After the validity test was conducted, SPSS 22 was used to further test the reliability of the trial questionnaire using the Cronbach's Alpha formula. The criteria used refer to the Limit of 0.6 to determine the level of instrument reliability. If the reliability value is <0.6 the instrument is considered to have poor reliability; 0.7 reliability is acceptable; 0.8 reliability is considered good; 0.9 reliability is very good. The results of the reliability test using Cronbach's Alpha showed that the questionnaire for the problem-based learning model had a score of 0.912, while the questionnaire for the differentiated approach obtained a score of 0.944. These figures indicate that both questionnaires can be considered reliable, with a score of 0.912 for the problem-based learning model and 0.944 for the differentiated approach where both are <0.6.

This study adopts several methodologies, including descriptive analysis, prerequisite testing, and hypothesis testing. Descriptive analysis is intended to summarize the results of sample data without drawing broader conclusions about the entire population. Before proceeding to hypothesis testing, prerequisite testing is carried out on the data that has been collected. These prerequisite tests include normality tests Kolmogorov-Smirnov, linearity tests, multicollinearity tests, and heteroscedasticity tests. In the hypothesis testing stage, various analysis techniques are applied, such as simple correlation analysis, simple regression analysis, multiple correlation analysis, multiple regression analysis, coefficient of determination analysis, and F-test.

Figure 1. Ex Post Facto Design

Group		Time ->
	Prior Event (s)	Investigation Period
Group 1	Exp	Obs
Group 2	-	Obs

Result and Discussion

On the variable of the learning outcomes of students in the natural and social sciences of grade V elementary school in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency in descriptive analysis is included in the good criteria, because the students' learning outcomes reached an average value of 73.52. The SAS value of students in the social sciences of grade V elementary school in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency in the descriptive analysis is included in the good criteria. The SAS value of students in the social sciences of grade V elementary school in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency is in all assessment predicates. The predicate "Very Good" with a value range of 80-100 (A) in the SAS results there are 29 students with a percentage of 27.4%. The predicate "Good" with a value range of 70-79 (B) in the SAS results there are 38 students with a percentage of 35.8%. The predicate "Enough" with a value range of 60-69 (C) in the SAS results there are 27 students with a percentage of 25.5%. The predicate "Less" with a score range of 50-59 (D) in the SAS results there are 11 students with a percentage of 10.4%. Then the predicate "Fail" with a score range of 0-49 in the SAS results there is 1 student with a percentage of 0.9%.

Descriptive analysis of the variables of the problem-based learning model of fifth grade elementary school students in the Mahesa Jenar Cluster, Ambara District, Semarang Regency obtained data that the problem-based learning model is classified as high. The value of 74.9% was obtained from the calculation of the index value related to the problem-based learning model variable. Based on the Three Box Method criteria, this index value is classified as high because it is in the range of 70.01-100.00. The three-box method criteria in descriptive analysis provide a structured approach to organizing and summarizing data. This technique promotes clarity and allows for easy comparison while helping to identify patterns or trends, all without implying any causal relationships. The application of effective techniques, such as the application of the problem-based learning model, has been proven to significantly increase students' understanding of the subject matter. According to Dahri (2022), the application of the problem-based learning model that is implemented properly and supported by relevant indicators can produce satisfactory learning outcomes for students. A more detailed explanation of each indicator is, the acquisition of the interest indicator index value of 75.3% which is included in the high category. Engage students by connecting learning materials to real-world issues, thereby enhancing their motivation to

participate actively in their studies. The acquisition of the attitude indicator index value towards learning is 74% which is included in the high criteria. The attitude indicator reflects students' positive perceptions of Project-Based Learning (PBL), fostering a welcoming classroom environment that boosts both confidence and discipline in the learning journey. The acquisition of the collaboration skill indicator index value gets the highest value among the other indicators, namely 76.8% which is included in the high criteria. The Collaboration Ability Indicator achieved the highest score due to the effectiveness of project-based learning (PBL), which encourages teamwork among students. By promoting active interaction, shared responsibility, effective communication, and adaptability, PBL creates a supportive environment that enhances productivity, problem-solving skills, social connections, and confidence, making the learning experience more meaningful and practical. Then the acquisition of the index value of the problem-solving skill indicator is 75.4% which is classified as high criteria, this indicator is closely related to learning with the problem-based learning model. The problem-solving skills indicator encourages students to actively engage in analyzing and addressing everyday challenges. This approach promotes collaboration, fosters constructive feedback, and connects their learning to real-world contexts. The acquisition of the last indicator index value of the level of understanding is 73%, which is classified as high criteria. Indicators of comprehension suggest that project-based learning (PBL) enhances student understanding. This improvement occurs as students engage in active exploration, apply what they've learned to real-life situations, and receive constructive feedback. Thus, this shows that each indicator in the problem-based learning model variable is classified as high criteria, which means that each indicator will have a high influence.

Differentiated approach variables for fifth grade students at SD Se-Gugus Mahesa Jenar, Ambarawa District, Semarang Regency according to the results of descriptive analysis, data obtained that the differentiated approach is classified as high criteria. Thus, it can be concluded that in each statement contained in the differentiated approach questionnaire, there is a high answer. Differentiated learning is a learning approach that aims to adjust the learning system in the classroom to the diverse learning needs and skills of each student. The main purpose of the differentiated approach is to support all students in achieving their educational goals (Marlina, 2020). The assessment of the index value for this approach shows a result of 75%. Based on the Three Box Method criteria, this figure is classified as high because it is in the range of 70.01-100.00. A detailed explanation of each indicator index is, the acquisition of the content differentiation indicator index value of 74.9% which is classified as high. Content differentiation involves tailoring learning materials to meet the diverse needs and comprehension levels of students. This approach aims to enhance their engagement and relevance in the educational experience. The acquisition of the process differentiation indicator index value of 75.1% is classified as high. The success of process differentiation becomes evident when diverse teaching methods are applied effectively, tailored to each student's learning style. This approach enables students to learn in the most optimal way for their individual needs. Furthermore, the third indicator index value is product differentiation of 74.6%, which is included in the high category. The Product Differentiation Index suggests that allowing students the freedom to express their understanding enhances their creativity and motivation during the learning process. The calculation of the learning style mapping index value obtained the highest value among other indicator indexes of 79.5%, which is included in the high criteria. The Learning Style Mapping Indicator stands out as the top choice due to its remarkable ability to boost student participation, understanding, and motivation. Its straightforward measurement and relevance in accommodating various learning styles help students feel appreciated and more actively involved in their educational journey. The acquisition of the feedback and continuous assessment index value of 71.9% is included in the high category. The Continuous Feedback and Assessment Indicator receives high marks for its effectiveness in offering clear and prompt feedback, which enables students to reflect deeply and enhance their understanding continuously. And the acquisition of the last indicator index value, a supportive learning environment of 74%, is included in the high category. The Learning Environment Index aims to promote positive interactions and collaboration among students, which are essential components of fostering active learning.

After the descriptive analysis was conducted, the researcher conducted a prerequisite analysis test. First, a data normality test was conducted to evaluate whether the data obtained followed a normal distribution. The Kolmogorov-Smirnov normality test is employed to assess normality, with decisions based on the significance value in the Sig row. If the test results show that the data is normally distributed, it means that the data represents the research population. A normality test is essential in ex post facto research examining the effects of Project-Based Learning (PBL) and differentiated instruction. This is because many statistical analyses used to assess relationships or effects,

such as t-tests and ANOVA, rely on the assumption that the data follow a normal distribution to yield valid results. Based on the results of the test assisted by SPSS 22 Kolmogorov-Smirnov test, the sig. (significance) value of the data on the results of learning outcomes of science, problem-based learning models, and differentiated approaches has a Sig. value > 0.05. The variable for learning outcomes of science has a Sig. value of 0.347, while the problem-based learning model shows a significance value of 0.247, and the differentiated approach has a significance value of 0.079. Based on these results, it indicates that the data for learning outcomes of science, problem-based learning models, and differentiated approaches are normally distributed. In addition, a linearity test is needed to evaluate whether there is a linear relationship between the two variables studied. Based on calculations assisted by SPSS 22, the Sig. column. (significance) Linearity row has a value of 0.037 meaning <0.05. In conclusion, the problem-based learning model shows a linear relationship with the results of learning science. In addition, the variable differentiated approach recorded a Sig. (significance) Linearity value of 0.47 where <0.05, which indicates that the variable differentiated approach with the results of learning science has a linear relationship. Third, the multicollinearity test is designed to evaluate the existence of a significant linear relationship between the independent variables in the regression model. Based on calculations assisted by SPSS 22, the Variant inflation Factor (VIF) value of the two independent variables is 1.059. In conclusion, the analysis carried out shows that there is no multicollinearity problem between the independent variables of both the problem-based learning model and the differentiated approach. This can be proven by the Variant Inflation Factor (VIF) value <10. Fourth, the heteroscedasticity test is carried out to assess the difference in residual variance in the regression model. In the regression results, there is no heteroscedasticity problem between Unstandardized Residual and the variables of the problem-based learning model and the differentiated approach because the Sig. value is > 0.05. The correlation between the problem-based learning model and Unstandardized Residual shows a Sig. level (significance) of 0.737. Meanwhile, the correlation between the differentiated approach and unstandardized residual shows a higher Sig. level (significance), which is 0.956.

Problem-based learning model impact on science learning outcomes. Simple correlation analysis shows a correlation coefficient of 0.200, which indicates a relationship between the learning model and learning outcomes. Based on the correlation coefficient interpretation guidelines, the value of 0.200 is included in the range of 0.200 - 0.399 which indicates a low level of relationship between the problem-based learning model variable and science learning outcomes. At the Sig. (significance) value, the Sig. value is 0.040, so H0 is rejected and Ha1 is accepted because the Sig. value is <0.05, so the correlation is said to be significant. The results of the analysis show that the t-count value of 2.084 is higher than the t-table value of 1.983. This indicates a significant influence of the problem-based learning model on the science learning outcomes of grade V students at SD Se-Gugus Mahesa Jenar, Ambarawa District, Semarang Regency, because the t-count value is obtained > t-table, namely 2.084 > 1.983. Based on R Square, it is proven that the problem-based learning model has an influence of 4% on the results of learning science in grade V elementary school students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency, the remaining 96% is influenced by other factors that were not examined in this study. An explanation of the influence of the problem-based learning model on the results of learning science can be seen in the Figure 1.

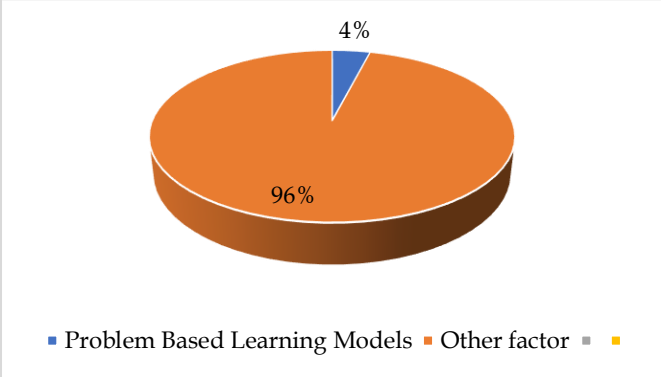

Figure 1. Diagram of the percentage of the effect of problem based learning model on IPAS learning outcomes

Research conducted by Nurvitasari et al. (2021) in a journal entitled "The Influence of Problem Based Learning Models on Student Learning Outcomes", strengthens this research. The results of the study show the influence value of R Square = 0.444, which means that the problem-based learning model contributes to learning outcomes by 44.4% and 55.6% of learning outcomes are influenced by other factors.

Differentiated approach has a significant impact on science learning outcomes. According to simple correlation analysis data, the differentiated approach variable gives a result of 0.192, so there is a relationship between the differentiated approach variable and science learning outcomes. Based on the correlation coefficient interpretation guidelines, the value of 0.192 is in the range of 0.00 - 0.199, this indicates that the differentiated approach variable has a very weak relationship with science learning outcomes. At the

significance level, it obtains a significance value of 0.048, so Ha2 is accepted because the Sig. value <0.05 and the correlation is declared significant. Furthermore, the t-count is 1.997 and the t-table is 1.983, so there is a significant influence between the differentiated approach and the science learning outcomes of grade V elementary school students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency because the t-table value> t-count is 1.997> 1.983. Based on R Square, it is concluded that the differentiated approach has an influence of 3.7% on the learning outcomes of grade V elementary school students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency, the remaining 96.3% is influenced by other factors. The influence of the differentiated approach on science learning outcomes can be seen in the following Figure 2.

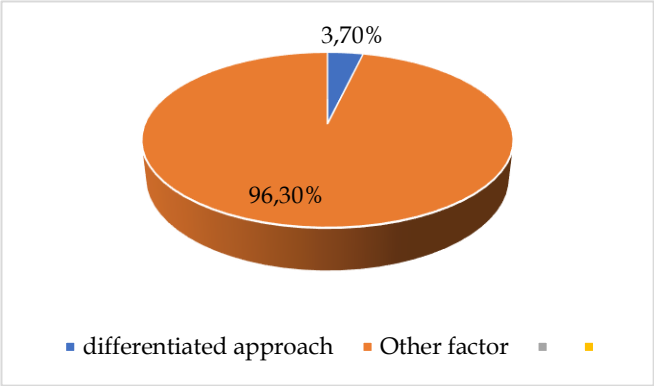

Figure 2. Percentage diagram of the influence of differentiated approaches on social science learning outcomes

Results the data acquisition was strengthened by research conducted by Pane et al. (2024) in a journal entitled Correlation of Differentiated Learning with Students Activity and Learning Outcomes in PAI Subjects at SDN 215 Bengkulu Utara, The coefficient of determination, calculated at 0. 1559%, indicates that differentiated learning (variable X) affects student learning outcomes (variable Y2) by a mere 0. 1559%. This leaves 99. 8440% of the variation in student learning outcomes influenced by other factors that are not examined in this study.

Problem-based learning model and differentiated approach together influence the learning outcomes of science. This is confirmed by the data of the multiple correlation of the variables of the problem-based learning model and the differentiated approach with an r-count value of 0.250. This shows that in the context of achieving science learning outcomes there is a low relationship between the problem-based learning model and the differentiated approach, which is caused by the R value being in the range of 0.2 - 0.399. The results of the F test at the Sig. level (significance) obtained a Sig. number of 0.036, so Ha3 was accepted because the Sig. value <0.05 and it can be concluded that the correlation is significant. Then the Fcount obtained 3.443 and Ftable 3.08 which means that there is a significant influence of the problem-based learning model and the differentiated approach on the learning outcomes of science of grade V students at SD Se-Gugus Mahesa Jenar, Ambarawa District, Semarang Regency because it obtained Fcount > Ftable, namely 3.443 > 3.08. Based on the results of the R Square analysis, the value is 0.063, so it can be concluded that the problem-based learning model and differentiated approach only contribute 6.3% to the science learning outcomes of grade V elementary school students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency, thus 93.7% is influenced by other factors. The impact of the problem-based learning model and differentiated approach on science learning outcomes can be seen in the following Figure 3.

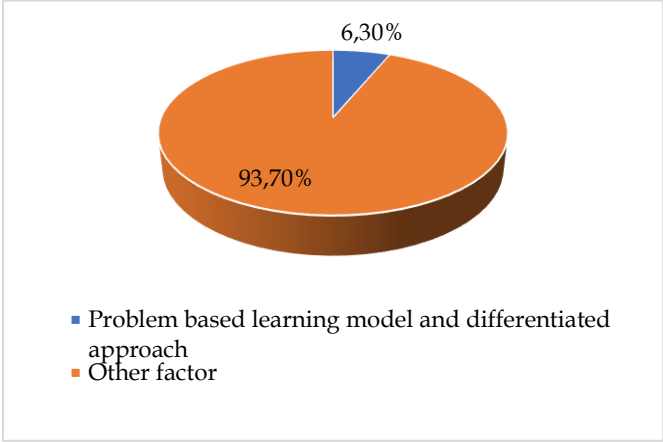

Figure 4. Diagram of the effect of problem based learning model and differentiated approach on IPAS learning outcomes

The results of this study are in line with the results of research obtained by Sitorus et al. (2023) in their study The Effect of Differentiated Learning Strategies Through Problem Based Learning on Learning Outcomes, the results of the study showed that differentiated learning strategies through the problem-based learning model had a positive and significant impact on the learning outcomes of class VIII students of Medan State Middle School with a percentage of 31%.

Problem-Based Learning (PBL) and differentiated approaches are essential in enhancing science learning outcomes by encouraging critical thinking and problem-solving through real-world engagement. These strategies not only boost student motivation by linking learning experiences to their interests and strengths, but they also foster vital skills such as teamwork and communication. Differentiation addresses the varied needs of learners, ensuring that every student has equal access to education. Research indicates that PBL can

significantly improve academic performance in science, while differentiated approaches tailor learning experiences to maximize individual outcomes. Together, these methods create an inclusive environment that supports effective science education for all students.

Conclusion

The study identified a correlation coefficient of 0. 200, indicating a significant relationship between the problem-based learning model and student learning outcomes. This finding suggests that this instructional method holds promise for improving educational effectiveness. Hypothesis testing revealed that the t-count of 2.084 surpassed the t-table value of 1.983, resulting in the rejection of the null hypothesis and the acceptance of the alternative hypothesis. This outcome confirms a notable impact of the problem-based learning model on the learning outcomes of fifth-grade elementary students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency. Furthermore, while the problem-based learning model accounts for 4% of the variance in science learning outcomes—highlighting its initial influence—an overwhelming 96% is attributable to various external factors that were not investigated in this study. The correlation analysis yielded a value of 0. 192, indicating a low yet significant relationship between the differentiated approach and science learning outcomes. This result highlights the potential of differentiated strategies to enhance student achievement. Furthermore, the hypothesis testing revealed that the t-count of 1. 997 exceeded the t-table value of 1. 983, leading us to reject the null hypothesis (H_{02}) and accept the alternative hypothesis (H_{a2}). This confirms a significant impact of the differentiated approach on the science learning outcomes of fifth-grade students in the Mahesa Jenar Cluster, Ambarawa District, Semarang Regency. While the differentiated approach explains only 3. 7% of the variance in learning outcomes, the remaining 96. 3% is attributed to other factors that were not examined in this study. The study's results reveal a correlation coefficient of 0. 250, indicating a low yet statistically significant relationship between the problem-based learning model and the differentiated approach in relation to science learning outcomes. This finding suggests that incorporating these teaching methods could improve educational practices. Furthermore, the analysis showed that the F-count (3. 443) surpassed the F-table value (3. 08), leading to the rejection of the null hypothesis (H_{03}) and the acceptance of the alternative hypothesis (H_{a3}). This outcome confirms a significant impact of both the problem-based learning model and the differentiated approach on the science learning achievements of fifth-grade students in the Mahesa Jenar Cluster, located in the Ambarawa District of Semarang Regency. Collectively, these two methods accounted for 6. 3% of the students' science learning results, while a substantial 93. 7% of the variance remains linked to other factors not explored in this study. Although the contribution percentage may be modest, these findings highlight the value of integrating diverse teaching strategies to enhance educational outcomes and suggest potential avenues for further research into other influencing factors.

Acknowledgments
I would like to express my gratitude to everyone who has contributed to the implementation of this research. I sincerely hope that the findings prove to be beneficial.

Author Contributions
Conceptualization, L.A. and I.R.; methodology, L.A.; data analysis using SPSS and Microsoft Excel, L.A; validation, I.R. and R.I.; formal analysis, L.A.; investigation, L.A.; resources, L.A.; data curation, L.A.: writing—original draft preparation, L.A.; writing—review and editing, L.A. and I.R.: Supervision, L.A.; All authors have read and agreed to the published version of the manuscript.

Funding
Researchers independently funded this research.

Conflicts of Interest
The authors declare no conflict of interest.

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