Implementation Of Differentiation Learning In Physics Lessons Material Moments Forces Using The Project Based Learning Model In Class XI MIPA SMAN 1 Singkil

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Abstract. This research delves into the implementation of differentiated learning using the PjBL model for grade XI MIPA science students at SMAN 1 Singkil. Employing three differentiated learning strategies—content, process, and product—integrated with the PjBL instructional model, the study aims to positively impact schools, classrooms, teachers, and students. The differentiated learning approach focuses on enhancing students' awareness of individual abilities, tailoring task difficulty to each student's readiness, and fostering a harmonious relationship between teachers and students. The study demonstrates that differentiated learning, when integrated with the PjBL model, unfolds as planned, creating an enjoyable learning atmosphere and allowing students the freedom to express their potential according to their interests. This integration proves to be a successful solution for addressing diverse student abilities within one class, resulting in a pleasant, collaborative, and meaningful learning environment.

Keywords: Implementation, Differeniated Learning, PjBL

1 Introduction

Education is a key aspect in the development of quality human resources. Physics, as part of the science curriculum, plays a crucial role in shaping students' understanding of natural phenomena. Effective Physics instruction should be able to meet students' learning needs by considering different learning styles.

In class XI MIPA at SMAN 1, the subject matter of Moments and Forces requires an innovative and project-centered learning approach. Project-Based Learning (PBL) can provide relevant context and actively engage students in their learning process. Meanwhile, Differentiation Learning allows teachers to tailor teaching methods to individual students' learning styles, enhancing understanding and retention of the material.

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The importance of implementing Differentiation Learning in teaching Physics is reinforced by previous research. [20], Differentiation Learning can provide a more effective and satisfying learning experience, especially when applied in science subjects like Physics. Additionally, indicates that Differentiation Learning has a positive impact on student achievement. [7]

However, there is still limited research specifically attempting to implement Differentiation Learning in the context of Project-Based Learning in Physics. Therefore, this study is aimed at addressing this literature gap and contributing to understanding the effectiveness of Differentiation Learning in Physics instruction using the Project-Based Learning approach.

Top of Form

Continuous efforts are necessary to enhance the overall quality of education and the specific quality of learning. Numerous national and international studies suggest that Indonesia has faced a prolonged learning crisis [3], exacerbated by the challenges of the Covid-19 pandemic [18]. Addressing these crises and challenges requires systemic changes, including those in the curriculum. Consequently, the Ministry of Education and Culture has introduced the Independent Curriculum as a crucial component of ongoing efforts to recover from the protracted crisis. This curriculum determines the subjects [21] taught in classrooms and significantly influences the pacing and teaching methodologies employed by educators to cater to students' needs [1].

Providing personalized attention and educational services tailored to the individual needs of each student is imperative. Every learner possesses unique characteristics, and for education to effectively accommodate these differences, it must be inclusive and responsive to the needs of every student. The diverse backgrounds and cultures in which students grow must be consistently taken into account. An independent curriculum grounded in humanism [9] is anticipated to offer all students opportunities for a quality education. The principles of independent learning afford teachers the flexibility to design classroom instruction, incorporating differentiated knowledge that accommodates the various needs and diversities of each student within the school. This approach is expected to positively impact the enhancement of comprehension, motivation in learning, and interactions among students in the classroom, particularly in the context of physics education.

Student-centered education places greater emphasis on understanding how students learn and the influence of the learning process on student development, particularly in physics education [2]. Physics education underscores hands-on expertise to explore and understand nature scientifically. Throughout their studies, students undergo meaningful learning experiences, enabling them to develop a deep appreciation for the values inherent in learning Physics.

In the physics curriculum for class XI MIPA, the topic of Forces and Moments requires students to visualize and discuss the equilibrium concept of rigid bodies. In recent years, the reality has been that the physics learning scores for class XI MIPA students at SMA Negeri 1 Singkil have been persistently low, failing to reach the specified Minimum Completeness Criteria (KKM). Students often find physics classes challenging, tedious, and lack motivation. This is attributed to issues such as learning approaches and methods, resulting in subpar outcomes in physics learning, evident in the formative test results of the first semester of the 2022/2023 academic year.

Table 1. Student learning outcomes before Differentiated learning

No	Mark KKM = 76	Pretest Score Achievement XII MIA-1	Percentage	Note
1	80-100	13	16.7 %	33.4%
2	70-79	13	16.7%	Complete
3	60-69	19	25%	66.6%
4	50-59	17	22.22 %	Not
5	<50	15	19.44%	Completed
Amount		77	100%	100%

Source: Physics teacher's book at SMAN 1 Singkil

This is evident from the document data for Physics teachers at SMA Negeri 1 Singkil for the academic year 2022/2023 in classes XI MIPA-1 to XI MIPA-3, consisting of 3 classes and a total of 78 students, which still falls below the expected criteria. There are numerous factors influencing the persistently low achievement in Physics learning outcomes, with one of them being that the teaching methods employed by teachers are not precisely targeted. Of course, there are many other interrelated factors. It is crucial for teachers to acknowledge that students have diverse learning needs and potential, including varying learning abilities, interests, and motivations, resulting in different levels of learning readiness. Educators must comprehend and facilitate this diversity. A learning approach capable of accommodating all students' needs is commonly known as differentiated learning. Differentiated learning involves rational decisions made by teachers to address students' needs based on learning objectives, the teacher's response to students' learning needs, creating an inviting learning environment, effective classroom management, and consistent assessment [19].

Differentiated learning comprises four aspects: (1) Content, which involves mapping students' learning needs and grouping them based on readiness, abilities, and interests. (2) Process, which refers to meaningful activities undertaken by students in the classroom, also grouped based on their readiness, interests, and learning profiles. (3) Product, indicating students' understanding of learning objectives through presented work or performances. (4) Learning Environment, including the personal, social, and physical structure of the class, tailored to students' readiness, interests, and learning profiles to enhance motivation to learn [22].

In essence, teachers must create a favorable atmosphere for students, ensuring they feel safe, comfortable, and calm during studies. According to [22], teachers can decide how these four elements will be integrated into classroom learning. Differentiated learning characteristics encompass an inviting learning environment, clearly defined curriculum objectives, continuous assessment, teacher responsiveness to student needs, and effective classroom management [12]. This approach becomes more meaningful when utilizing constructive learning models, such as the project-based learning (PjBL) model.

PjBL is a learning model incorporating various ideas supported by comprehensive theories involving students in cooperative and sustainable investigation activities. It aligns with the constructivist philosophy, asserting that knowledge results from cognitive construction through student activities. This includes scientific skills and attitudes, allowing students to construct meaningful knowledge through real experiences [23]. Learning with the PjBL model enhances students' critical and creative thinking abilities in biology learning [8]. Another study found that the PjBL model effectively increased interest in learning and improved student learning outcomes. The PjBL model comprises six components: (1) determining fundamental questions, (2) designing projects, (3) preparing schedules, (4) monitoring project progress, (5) presenting results, and (6) evaluating. The model encourages student activity in learning, with the teacher assuming the role of a facilitator, being more prepared before lessons to ensure effective and targeted learning [14].

Based on the aforementioned explanation, this research was conducted to meet the needs of students in Physics regarding the Moments of Style in class XI MIPA at SMAN 1 Singkil by implementing differentiated learning using the project-based learning model. My roles and responsibilities in this practice include conducting an initial diagnosis, designing a differentiated learning implementation plan (RPP) with the PjBL model, conducting lessons, and evaluating learning outcomes.

2 Method

This research employs a mixed-methods approach, integrating both qualitative and quantitative elements. This approach is chosen to provide a comprehensive understanding of the effectiveness of Differentiation Learning and Project-Based Learning in enhancing students' comprehension of physics material. Population and Sample The population of this study consists of 77 students in class XI MIPA at SMA Negeri 1 Singkil, comprising 41 male students and 36 female students. The sample for this research includes the entire student population. Research Instruments The research instruments utilized encompass surveys, questionnaires, classroom observations, and interviews. Surveys and questionnaires are employed to gather quantitative data from students, physics teachers, and parents, while observations and interviews provide in-depth qualitative data. Data Collection Process Data collection involves surveys and questionnaire development to obtain general perspectives, as well as classroom observations for a direct understanding of the implementation of Differentiation Learning and Project-Based Learning. Interviews with physics teachers will offer profound insights into their experiences in implementing these teaching methods. Data Analysis Quantitative data will be analyzed using descriptive statistical methods to evaluate the impact of Differentiation Learning and Project-Based Learning on students' academic achievement. Qualitative data from observations and interviews will be thematically analyzed to gain a profound understanding of participants' experiences and perspectives.

3 result and discussion

The application of Differentiated Learning with the PjBL learning model for Class XI MIPA students took place on July 27 and August 1, 2023. The initial phase involved assessing and

understanding the needs and attributes of the students. Organizing the students' needs and characteristics is intended to inform the planning of an effective learning process that yields meaningful educational outcomes. In this study, the mapping of learning needs focused on evaluating the students' readiness for learning. This mapping process employed a cognitive diagnostic assessment to derive insights from the assessment outcomes.

Fig. 2. Diagnostic Test

Based on the findings of the research, differentiated learning employs strategies encompassing content, processes, and products. Content differentiation involves adjusting the content of Learner Worksheets (LKPD) to align with students' learning readiness levels, along with providing various learning resources such as articles, teaching materials, power points, images, and videos.[6] It is crucial to ensure that the instructional content addresses the same concepts for all students, but the complexity level must be tailored to accommodate the diverse needs of students.

Process differentiation is executed by tailoring the guiding questions on the LKPD to be completed based on individual learning readiness and predetermined groups. Moreover, process differentiation involves varying the time allocated for students to complete the LKPD. This aims to offer additional support to students facing challenges while encouraging fast learners to delve deeper into the topics. Another aspect of process differentiation is providing specific treatment to each study group. The advanced group is granted the autonomy to independently explore understanding through guided questions. The developing group has the opportunity to explore their capabilities with guidance, while new groups seeking development receive full guidance during the learning process. According to Bao [6], process differentiation learning entails students engaging in higher-order thinking activities, small group instruction, multiple intelligence, focused learning, and collaborative tasks.

Product differentiation in this study involves allowing students to create free-report products, which can take the form of videos, podcasts, posters, powerpoints, or narrative images. Even though students have flexibility in their work products, the teacher still determines the necessary content, desired work quality, and expected goals or final outcomes. According to [22], the product represents the culmination of learning, showcasing students' ability to demonstrate their knowledge, skills, and understanding after completing the learning process.

Fig.3. Stages First Prepare Project Questions/Assignments

The previously explained differentiated learning is seamlessly incorporated with the PjBL learning model. The initial phase in the process of differentiated learning with the PjBL learning model involves the formulation of project questions/assignments. During this phase, the teacher provides project assignments related to the moment of force material in worksheets, which are then discussed and analyzed within assigned groups. Differentiated learning is applied in both content and processes during this stage, tailoring the content and activities to the students' individual learning readiness levels. This phase also encourages students to delve into their understanding of the concept of moment of force.

The subsequent phase involves the creation of the project plan. Within their respective groups, students engage in project design, selecting and understanding project procedures. Additionally, during this phase, students collaboratively discuss task assignments, including the preparation of tools, materials, and other required resources. The activity stage encompasses the development of a schedule outlining the steps needed to complete the project. In this phase, group members reach an agreement on the schedule and the sequential steps involved in crafting the Moment of Style project. The fourth phase focuses on monitoring, where students, due to project limitations and considerations, finalize the moment of style project. Notably, the project completion is conducted at the residence of one of the student group members.

Throughout the second, third, and fourth stages of differentiated learning, teachers apply adjustments to both content and processes. The content within the Learner Worksheets (LKPD) is tailored to accommodate the diverse learning readiness levels of the students.

Fig. 4. Stages two, three and four in groups a) proficient, b) developing, c) just about to develop

The evaluation phase marks the fifth stage within PjBL learning. During this stage, students and teachers collaboratively analyze the outcomes of the style moment project. Students present their results, engaging in discussions and responding to the work of other groups. In this phase of product differentiation learning, students generate style moments with diverse designs, showcasing them in front of the class. The concluding stage in PjBL learning involves the assessment of the overall experience. At this point, students share their insights into the process of creating style moment projects. Additionally, students and teachers collectively draw conclusions regarding the project's outcomes.

Fig. 5. Example of student product differentiation results

The process proceeds with an assessment and reflective phase. During the evaluation phase, students are presented with questions to gauge the effectiveness of their learning. Subsequently, reflection takes place, prompting students to pose inquiries that contribute to an assessment. The outcomes of the learning experience are outlined in the table below.

Table 2.Posttest Values for Physics Learning Results for Direct Current Circuit Material

No	Mark KKM = 76	Pretest Score Achievement XII MIA-1	Percentage	Note

1	80-100	34	44.44 %	72.23%
2	70-79	21	27.77%	complete
3	60-69	17	22.22%	27.77%
4	50-59	5	5.55 %	Not Completed
5	<50	-	-	
Amount		77	100%	100%

Source: The physics teacher's Legger book at SMAN 1 Singkil

Based on the information provided, it was observed that the outcomes of students' physics learning in the series of moments of force material within the PJBL differentiated learning approach yielded highly favorable results. This is evident in the percentage of students who achieved a score of KKM = 76, totaling 72.23%, equivalent to 26 students, while those who did not meet the criteria amounted to 27.77%, totaling 10 students.

The assessment extends to the learning process and students' reflections following the completion of the learning process. According to [4], meaningful learning is closely linked to reflection. This aligns with [15], who emphasized that reflecting on experiences, emotions, and knowledge, followed by an evaluation, leads to enhancements and provides insights for future actions. Reflection serves as a valuable resource or tool to guide students toward meaningful learning, as it encourages the integration of prior knowledge with new information, resulting in positive responses [10].

Figure 6. Implementation of Reflection (Teacher Asks About Students' Feelings)

Figure 7. Students carry out assessments as evaluation material

The implementation of differentiated learning is expected to have a significant impact on schools, classrooms, teachers, and particularly students. According to [11], the goals of differentiated learning encompass the following aspects: 1) assisting all students in their learning journey, promoting the achievement of learning objectives by enhancing awareness of individual abilities, 2) boosting motivation and improving student learning outcomes by tailoring the difficulty level of tasks according to each student's readiness, 3) fostering a

harmonious relationship and strengthening the bond between teachers and students to enhance enthusiasm for learning, 4) guiding students towards becoming independent individuals who value diversity, and 5) enhancing the teacher's sense of satisfaction and challenge, thereby cultivating creativity. Differentiated learning is presented as a viable solution for addressing the diverse range of students' abilities within a single classroom, resulting in an enjoyable, collaborative, and meaningful learning environment [16].

4 Conclusion

This research explores the implementation of differentiated learning using the PjBL model for grade XI science students at SMAN 1 Singkil. In this study, teachers employed three differentiated learning strategies—content, process, and product—integrated with the PjBL instructional model. The primary objective of differentiated learning is to have a positive impact on schools, classrooms, teachers, and particularly students. In this context, the goals of differentiated learning are evident: Assisting all students in the learning process: Enhancing awareness of individual abilities by motivating students to achieve learning objectives. Increasing motivation and student learning outcomes: Tailoring the difficulty level of tasks to each student's readiness for learning. Building a harmonious relationship between teachers and students: Strengthening the teacher-student relationship to enhance enthusiasm for learning.

The research results indicate that the implementation of differentiated learning with the PjBL model proceeded as planned, creating a enjoyable learning atmosphere and providing students with the freedom to express their potential according to their interests. Thus, the integration of differentiated learning with the PjBL model can be considered a successful solution in addressing diverse student abilities within one class, resulting in a pleasant, collaborative, and meaningful learning environment.

References

[1] Arifin, MZ, & Setiawan, A. (2020). Teachers' Learning and Teaching Strategies in the 21st Century. Indonesian Journal of Instructional Technology, 1(2), 37–46.

[2] Aziz, R. (2018). Implementation of Curriculum Development. Journal of Inspirational Education, 7(1), 44–50.https://doi.org/10.24252/ip.v7i1.4932

[3] Budiarto, G. (2020). Indonesia in the Maelstrom of Globalization and Its Influence on Moral and Character Crisis. Pamator's Journal: Trunojoyo University Scientific Journal, 13(1), 50–56. https://doi.org/10.21107/pamator.v13i1.6912

[4] Fiddler, Morris, and Catherine Marienau. 2008. "Developing Habits of Reflection for Meaningful Learning." New Directions for Adult and Continuing Education no 18(118): 75–85.

[5] Hamidah, Isrohani, and Sinta Yulia Citra. 2021. "Effectiveness of the Project Based Learning (PjBL) Learning Model on Student Interests and Learning Outcomes." BIOEDUSAINS:Journal of Biology and Science Education 4(2): 307–14.

[6] Hasniar. 2022. "Differentiated Learning With Quizizz." South Sulawesi BPSDM Sipatokkong Journal Volume 3 Number 4: 193–208.https://ojs.bpsdmsulsel.id/.

[7] Hattie, J. (2012). Visible Learning for Teachers: Maximizing Impact on Learning. New York: Routledge

[8] Indah, Reski Alma, Rahmadhani Fitri, and Muhyiatul Fadilah. 2022. "The Effect of Applying PJBL in Biology Learning on Increasing Critical and Creative Thinking Skills." Classrooms: Journal of Biology Education 2(3): 27–33.

[9] Juita, D., & M, Y. (2021). The Concept of "Freedom to Learn" in the Perspective of Humanistic Learning Theory. Spectrum: Journal of Out-of-School Education, 9(1), 20–30. https://doi.org/10.24036/spektrumpls.v9i1.111912

[10] Kainde, Elisabeth Wulan, and Candra Yulius Tahya. 2020. "Using Reflective Journals as a Guide for Students in Finding Meaning in Chemistry Subjects." Journal of Educational Chemistry (JEC) 2(2): 49.

[11] Marlina, Marlina. 2020. Differentiated Learning Strategies in Inclusive Schools. Padang: Afifa Utama.

[12] Novita Sarie, Fitria SD. 2022. "Implementation of Differentiated Learning Using the Problem Based Learning Model for Class VI Elementary School Students." Journal of Basic Education: Tunas Nusantara Journal Volume 4 Number 2 T.

[13] Nur Apriliani, Dini, and Vertika Panggayuh. 2018. "The Influence of the Use of Project Based Learning (PjBL) Based Learning Models on Learning Interests and Learning Outcomes of Class X Rpl Students at State Vocational School 1 Boyolangu." JOEICT(Journal of Education and Information Communication Technology) 2(1): 19–26.

[14] Poldner, Eric et al. 2014. "Assessing Student Teachers' Reflective Writing through Quantitative Content Analysis." European Journal of Teacher Education 37(3): 348–73.

[15] Puspitasari, Verdiana, Djoko Adi Walujo, Postgraduate Program, and PGRI Adi Buana University Surabaya. 2020. "Development of Learning Devices with a Differentiation Model Using a Book Creator for Science Learning in Classes with Diverse Abilities." E.ISSN.2614-6061P.ISSN.2527-4295Vol.8 No.4 Edition November 2020Jurnal of Education and developmentSouth Tapanuli Education Institute vol.8 no.4.

[16] Santoso, IH, & Rachmawaty, M. (2020). Online Learning: The Pursuit of Achievement and Prestige. Journal of Sustainable …. Taken from http://journal.pdmi-Pusat.org/index.php/jsbh/article/view/6

[17] Sopianti Dewi. 2022. "Implementation of Differentiated Learning in Class XI Culture Subjects at SMAN 5 Garut." Journal of Music Education Vol. 1 No. 1 (2022)(Arts Education in an Era of Disruption): 1–8.
[18] Sukmadinata, NS 2011. Educational Research Methods. Bandung: PT. Rosdakarya youth.
[19] Suryana, Y., & Ismi, FM (2019). Curriculum Management in Improving Graduate Quality. Isema Journal: Islamic Educational Management, 4(2), 257–266.
[20] Tomlinson, C. A. (2001). How to Differentiate Instruction in Mixed-Ability Classrooms.
[21] Wahyuningsari Desy et al. 2022. "Differentiated Learning in the Context of Realizing Freedom of Learning." Journal of Education Window Volume 2 No. 04. https://www.ejournal.jendelaedukasi.id/index.php/JJP (April 1, 2023).
[22] Wulandari, Ade Sintia, Nyoman Suardana, NL Pande, and Latria Devi. 2019. "The Influence of Project-Based Learning Models on Middle School Students' Creativity in Science Learning."