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# Analysis of Student Self-Regulation in Differentiated Learning with Atomic Model Material: A Case Study of Junior High School Students

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**Abstract**

Differentiated learning is one of the learning strategies that can be applied to the Merdeka Curriculum. This approach is expected to maximize individual progress and create a more positive learning experience. This research aims to determine the profile of students' self-regulation and its relationship to the application of a differentiated learning approach. There were 135 research subjects obtained through a purposive sampling technique with the criteria being that students received learning using a differentiated approach to atomic material models. Data collection used research instruments adapted from the Learning and Study Strategies Inventory (LASSI) to measure students' self-regulation, as well as formative assessment scores to determine the scores resulting from the differentiated approach to atomic material models. Based on descriptive analysis and correlation tests using Pearson's product-moment correlation analysis techniques, the results showed that there was no significant positive relationship between the application of a differentiated approach to student self-regulation ($p > 0.05$ and $r = 0.012$). However, the self-regulation variable shows a score in the quite good category of 6.67% and the good category of 93.33%. This shows that students' self-regulation profiles tend to be at a good level. This study provides valuable insights into the relationship between differentiated learning, atomic model material, and student self-regulation. By understanding these factors, educators can implement strategies to enhance student self-regulation and improve overall academic outcomes. Further research is needed to explore the long-term effects of differentiated learning on student self-regulation and academic achievement.

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## INTRODUCTION

The main basis for designing the Merdeka Curriculum is the Independent Learning philosophy. Based on Minister of Education and Culture Regulation Number 22 of 2020, it states that the curriculum formed by the Independent Learning Policy or flexible characteristics is based on competency, focuses on character development and soft skills and is accommodating to world needs (Permendikbud, 2020). The implementation of a Merdeka Curriculum has characteristics, one of which is implementing flexible learning so as to give educators the freedom to create quality learning that suits students' needs and learning environment. One effort to implement learning that is flexible and can meet students' learning needs is through differentiated learning.

Differentiated learning is carried out based on students' level of learning readiness, requiring teachers to assess prior knowledge and determine what students already know and where students are (Tomlinson, 1999). Differentiated learning strategies that can be implemented in schools are through content differentiation, process differentiation and product differentiation. Teachers can modify lesson content, learning processes, products or results of the learning taught,

as well as the learning environment in which students learn (Tomlinson, 1999). The differentiated learning process is implemented by schools in order to free students in learning because students are not required to be the same in everything as others.

The implementation of differentiated learning requires teacher readiness in preparing learning tools, learning steps and assessments. This is done in accordance with the readiness of students in learning the subject matter, interests and how to deliver lessons in accordance with the learning profile of the students (Kristiani et al., 2021).

According to Tomlinsom (2013), there are five principles that can help teachers when implementing differentiated learning. The first is an environment that encourages and supports the quality of learning. Second is a quality curriculum. Some basic things about a quality curriculum are the goals that students must achieve, foster student understanding and can involve students in learning. Third is continuous assessment. Teachers should carry out formative assessment in learning as feedback to improve the learning process and begin by carrying out an initial assessment or diagnostic assessment to map students' competencies and interests. Fourth is responsive teaching that occurs between teachers and students based on the results of previously conducted assessments. Fifth is leadership and routine in the classroom. Leadership is interpreted as the teacher's role in leading conducive learning activities in accordance with the class agreement set together while classroom routines refer to the teacher's skills in managing the classroom (Purba et al., 2021).

One learning approach that can support independence in learning is differentiated learning. (Anggraini et al., 2023). This will be related to self-regulation which refers to learning that results from students' own thoughts and behavior that is systematically oriented towards achieving their learning goals where students' cognition can influence the drive, direction and persistence of achievement behavior (Bandura A, 1997). This ability is called self-regulation ability.

Self-regulation is a basic concept for understanding cognitive components in the learning process (Ma & Guo, 2023). In general, according to Peters et al. (2022) self-regulation includes cognitive, behavioral, motivational and affective/emotional aspects of learning. Based on research conducted by Okada, M., et. al. (2024) self-regulated learning is when a learner autonomously acquires knowledge by experiencing the world without being explicitly taught. There are several models of self-regulation approaches that have similar elements and processes (Chen & Bonner, 2020). In the Zimmerman model, the self-regulation approach process is divided into three cyclical phases, namely forward thinking, performance or volitional control, and self-reflection (Zimmerman, 2000). Meanwhile, Pintrich (2002) formulated a conceptual framework and identified four phases of SRL, namely motivation, cognition, personal, and context.

Good self-regulation can improve the learning process (Higgins et al., 2021; Voskamp et al., 2022), students' meta-cognitive abilities (van der Graaf et al., 2023; Versteeg et al., 2021) and build self-motivation and student self-efficacy (Fokkens-Bruinsma et al., 2021; Ho et al., 2022; Tan et al., 2021). In research conducted by Granberg et al. (2021) regarding a case study of the use of formative assessment and its impact on self-regulation shows the significant influence of both qualitative and quantitative data. In addition, many studies have been conducted using a self-regulation approach in learning for students (Porter & Peters-Burton, 2021; Voskamp et al., 2022), as well as students and prospective teachers (Michalsky, 2021; Tolppanen et al., 2021; Yigletu et al., 2023).

There are several factors that can influence independence in learning. Self-regulation carried out by students was stated by Zimmerman (1989) who described the relationship between environmental self-regulation, self-regulation (person) and behavioral self-regulation. One factor that influences this is the environment. Referring to the environment that influences students' independence, there is a role of peer groups in forming student independence because students spend more time with their peers at school (Kartika, et. al., 2021). Research in Indonesia regarding differentiated learning which influences learning independence was conducted by Sahril, et. al. (2021) where differentiated learning was proven to be able to strengthen students' learning independence because in the process students felt appreciated and motivated to take the initiative in managing their own learning process such as seeking additional information and developing their understanding on the material studied proactively. Anggraini et al. (2023) stated that the differentiated learning approach of the Problem Based Learning learning model can increase the learning independence of class IX students in mathematics.

There has been a lot of research on student self-regulation, especially in Indonesia. Such as research conducted on the influence of self-regulation on scientific literacy (Sugiyarti, et. al., 2020), the influence of student self-efficacy and self-regulation on mathematics learning outcomes (Rustam and Wahyuni, 2020), and the relationship between student self-regulation and academic procrastination (Sedyawati, 2021; Aisyah, et al., 2022).

However, not much research has been done to determine the effect of differentiated learning on students' self-regulation, especially in science subjects at junior high school level on certain material. Research on the interplay between student self-regulation and differentiated instruction, particularly within the context of science education, remains relatively limited. While extensive research exists on self-regulation in general and its application to subjects like reading and mathematics, studies specifically examining this construct in science, especially through the lens of atomic model utilization, are scarce. Moreover, while the impact of differentiated instruction on student outcomes has been widely explored, its specific influence on self-regulation requires further investigation. Additionally, the literature often overlooks the role of contextual factors, such as school culture and teacher expertise, in shaping students' self-regulatory capabilities within differentiated learning environments.

By investigating how differentiated instruction can support student self-regulation in a science context, this study contributes to a growing body of knowledge that addresses the evolving needs of modern education. This research aligns with the broader goal of equipping students with the lifelong learning skills necessary for success in a rapidly changing world**.** Based on previous findings, this study aims to investigate the impact of differentiated learning with atomic model material on the self-regulation skills of junior high school students. By examining how this instructional approach influences students' ability to manage their thoughts, emotions, and behaviors, we seek to understand the potential benefits of tailoring instruction to individual needs and the role of tangible learning tools like atomic models in fostering self-directed learning. To achieve this, the research will address the following questions: (1) What is the level of self-regulation exhibited by junior high school students participating in differentiated learning with atomic model material? and (2) Is there a correlation between students' self-regulation and their academic performance in science when exposed to differentiated learning with atomic model material?

## RESEARCH METHOD

The method used in this research is a exploratory case study with a qualitative research approach. An exploratory case study investigates the capacity of a multidisciplinary approach to academic development to empower adaptive responses to technological change impacting teaching practice (Flavell H., et. al., 2019). The subjects in this research were 135 class VII students of SMP Negeri 36 Bandung for the 2023-2024 academic year. The research design is primarily cross-sectional. This means that the study collected data from participants at a single point in time, allowing for comparisons between groups and the examination of relationships between self-regulation and academic performance. Although case study elements might have been included for in-depth exploration, the overall design is cross-sectional, providing a snapshot of the situation at a specific time (Spector, P., et al., 2019).

The selection of participants used a *purposive sampling method* with the criteria for participants being students who received learning with a differentiated approach to atomic model material. Purposive sampling was likely used in this study to select participants who were particularly relevant to the research objectives. By focusing on specific groups of students with varying levels of self-regulation, prior knowledge, or learning styles, the researchers aimed to maximize the variation in the sample and obtain a deeper understanding of the relationship between self-regulation, differentiated learning, and atomic model material. This targeted selection aligns with the case study's focus on in-depth exploration and provides valuable insights into the specific context of the study. The research was carried out by distributing research instruments in the form of questionnaires which were carried out in parallel classes.

The instrument used in this research used a student self-regulation tracking questionnaire adapted from *the LASSI instrument* . Based on the adaptation of *self-regulation* indicators according to Boekaerts (1997), *self-regulation indicators* include seven categories. The LASSI adaptation scale has 28 items which are divided into 7 *self-regulation categories* where each category consists of 4 questions and has 4 choices, namely Strongly Disagree (STS), Disagree (TS), Agree (S), and Strongly Agree ( SS). The LASSI score research is based on Haught, et. al. (1998) reference with score categories of 1.00-1.49 not good, 1.50 - 2.49 quite good, 2.50 - 3, 49 is good as well as 3.50 - 4.00 is very good.

Apart from measuring *self-regulation* based on seven categories, another thing that is measured is students' learning gains in atomic model material through formative assessments with scores on a scale of 1-100. The data analysis used is descriptive analysis to determine students' self-regulation profiles, as well as correlation analysis using the Pearson's product-moment correlation analysis technique from Karl Pearson with the help of Statistical Product and Service Solution (SPSS) software version 27.0 for Windows. The following is the formula product moment for Pearson correlation (de Winter, J. D., et al., 2016).

$$r_p = \frac{\sum_{i=1}^{N} x_i y_i}{\sqrt{\sum_{i=1}^{N} x_i^2 \sum_{i=1}^{N} y_i^2}}$$

## RESULT AND DISCUSSION

Based on the results of descriptive tests and categorization of self-regulation score data as the dependent variable, the results were 6.67% in the quite good category and 93.33% in the good category. Calculation of empirical values and hypothetical values aims to compare hypothetical data and data obtained in the field. Comparison of the magnitude of the hypothetical score with the empirical score in this study shows that students' differentiated approaches and self-regulation are higher than expected. The subject's mean self-regulation score was higher than expected, namely 78.2. Meanwhile, the average score for the differentiated approach was 87.47. Empirical standard deviation values that are lower than hypothetical standard deviation values indicate that participants typically provide consistent responses on the research scale. The distribution of hypothetical scores and empirical scores can be seen in Tables 1 and 2.

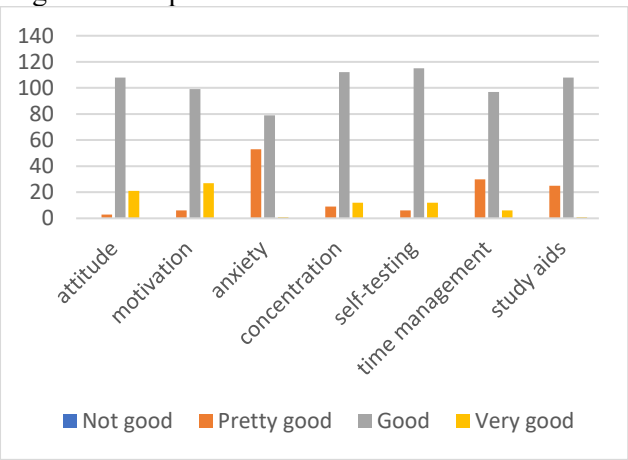
Table 1. Hypothetical Data and Empirical Data (N=135)

| Variable | Hypothetical Value | | | | Empirical Value | | | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Av. | Stand. Dev. | Min | Max | Av. | Stand. Dev. |
| Approach Differentiate | 0 | 100 | 50 | 16.67 | 0 | 100 | 87.47 | 14,18 |
| Self-Regulation | 28 | 112 | 70 | 14 | 65 | 97 | 78.2 | 6.17 |

Table 2. Categorization of Self- Regulation Scores

| **Category** | **Score** | **Amount** | **Percentage** |
|---|---|---|---|
| Not good | 1.00 - 1.49 | 0 | 0% |
| Pretty good | 1.50 - 2.49 | 9 | 6.67% |
| Good | 2.50 - 3.49 | 126 | 93.33% |
| Very good | 3.50 - 4.00 | 0 | 0% |
| Total | | 135 | 100% |

Figure 1. Graph of Categorization of Self-Regulation Aspects




The results of research hypothesis testing were carried out using parametric statistical analysis with the Pearson Correlation technique. Pearson Correlation aims to analyze the relationship between differentiated learning and student self-regulation. The results of the correlation analysis are in Table 3.

Table 3. Correlation Data

| Variable | Pearson Correlation (r) | p |
|---|---|---|
| Learning Differentiate*Self-Regulation | 0.012 | 0.893 |

The results of hypothesis testing using the Pearson analysis technique show a value of 0.012 with a significance level of 0.893 ($p > 0.05$), which means the hypothesis is not accepted, namely that there is no positive relationship between differentiated learning and student self-regulation.

Based on the results of descriptive tests and categorization of self-regulation scores as the dependent variable, the results were 6.67% in the quite good category and 93.33% in the good category. Obtaining this self-regulation score is divided into 7 categories which include attitude, motivation, anxiety, concentration, self-testing, time and study aids. Based on the distribution of self-regulation scores from each aspect, the anxiety aspect or level of anxiety with indicators of worry in work and learning performance of students has the highest score in learning. The self-regulation score in the good category, namely 93.33%, has the highest score in the self-testing category with indicators of self-reflection, and reviewing learning and preparing oneself.

The analysis of student self-regulation across six key dimensions—attitude, motivation, anxiety,

concentration, self-testing, time management, and study aids—reveals that students generally have positive attitudes towards the learning process and demonstrate strong concentration skills. However, motivation levels vary, anxiety levels are moderate, and time management skills appear to be a challenge for some students. Additionally, the use of study aids is relatively limited. Overall, the data suggests that differentiated learning and the use of atomic model material have a positive impact on student self-regulation, but there is still room for improvement in certain areas.

The level of anxiety or anxiety occupies the highest score in the quite good category, this shows that while participating in differentiation learning activities can minimize students' anxiety levels. This is in line with research conducted by Hasanah, E., et. al. (2023) that differentiated learning can minimize students' anxiety levels. Self-testing has the highest score in the good category with indicators of self-reflection, reviewing learning and preparing oneself. Likewise, the good category is related to self-testing, where students are able to self-reflect, and review learning and prepare themselves for the learning activities that will be carried out.

The two categories in self-regulation are minimizing anxiety and students' ability to carry out self-testing related to differentiation learning carried out in class VII on atomic model material. The differentiation learning carried out is content differentiation learning. When implementing content differentiation, teachers consider students' learning needs by paying attention to learning readiness, interests, learning profiles (Sutrisno, 2023). It can also be differentiated based on responses to a combination of readiness, interest and learning profile (Oskarsson & Johansson, 1987).

Learning on atomic model material using content differentiation is carried out based on learning styles. Students are grouped into groups and divided into three different treatments. The first treatment is for students to analyze learning videos, carry out atomic simulations through phet simulation and carry out simulations directly. Through differentiated learning, students look enthusiastic and play an active role in learning activities. This is in line with what was stated by Aulia et al. (2023) that differentiated learning strategies also emphasize the importance of educators' responses to students' learning needs, where educators do not force learning but focus on the learning needs of each student. Additional data obtained from differentiated learning activities are student learning outcomes through formative assessments. The results of formative assessments during learning activities have an average or mean value of 87.47. This shows that differentiated learning can improve student learning outcomes. As has been done by Raja, et. al. (2024) that differentiated learning is effective in improving students' abilities, with success factors including internal factors (intelligence, interest, motivation) and external factors (learning environment, way of presenting material).

Self-regulated learning (SRL) in undergraduate science education can enhance students' awareness, control, and success in complex scientific concepts (Higgins et al., 2021). In Japan, SRL can address educational issues by enabling students to express and record their thoughts, fostering the construction of scientific concepts (Wada, 2021). SRL is influenced by various factors, including self-regulation, learning outcomes, critical thinking, scientific literacy, motivation, problem-based learning, inquiry, and discovery learning (Ramadhani et al., 2022). While SRL improves over time in undergraduate science, initial scientific confidence is crucial for long-term university success (Higgins et al., 2021). Technology-enriched environments in higher education are increasingly focusing on SRL, with Zimmermann's model being widely used and questionnaires being the primary data collection method (Urbina et al., 2021).

The Merdeka Curriculum has now been implemented in almost every educational unit, one of which is in the State Junior High School in Bandung City. Learning with a new paradigm that is centered on students, one of which is implementing differentiated learning. Differentiated learning based on previous research can improve student self-regulation because learning will be tailored to student learning needs. This can be done by mapping the learning needs of students through the provision of cognitive diasnogtic assessments and non-cognitive assessments (Hertberg-Davis, H., 2009). However, not all educators in the field have mapped students' learning needs by conducting early learning assessments.

A differentiated approach is a learning approach that accommodates students' learning needs by providing facilities that suit their needs (Esingeldinov, B., et. al., 2021). Student self-regulation, on the other hand, is students' ability to regulate their behavior and emotions in achieving learning goals (Rodríguez, S., et. al., 2022). Although a differentiated approach and student self-regulation are both important in the learning context, they do not have a direct correlation. A study shows that a differentiated approach can increase student diversity and uniqueness, while student self-regulation can help students become

independent learners and have an attitude of respect for diversity (Kaplan, S. (2022). However, no research has been conducted to show that a differentiated approach directly influences students' self-regulation. Although the two do not have a direct correlation, a differentiated approach and student self-regulation are still important in creating an inclusive and efficient learning environment.

The findings of this study have several implications for educational practices. Differentiated learning approaches can be tailored to meet the individual needs of students, fostering self-regulation and promoting academic success (Theobald, M., 2021). The use of atomic model materials can enhance student engagement and understanding of complex scientific concepts. Educators should receive training on strategies for promoting self-regulation in students, including the use of differentiated learning and atomic model materials. Educational policymakers can consider incorporating differentiated learning and atomic model materials into curriculum guidelines and standards.

Future research should focus on longitudinal studies to examine the long-term effects of differentiated learning and atomic model materials on student self-regulation and academic achievement. Additionally, comparative studies can be conducted to compare the effectiveness of different differentiated learning approaches and atomic model materials in promoting self-regulation and student outcomes. Furthermore, the relationship between self-regulated learning and technology integration self-efficacy, which positively affects technological pedagogical content knowledge (TPACK) (Ratih, I., et. al., 2024), should be explored in future research. The impact of contextual factors, such as school culture, teacher characteristics, and socioeconomic status, on the effectiveness of differentiated learning and atomic model materials should also be investigated. Another way is to use the computational learning analysis conducted by Okada, M., et. al. (2024) so as to estimate the learner's self-regulation mechanism in real-world learning, thus helping a better understanding of the world.

As researchers, we believe that this study highlights the importance of fostering self-regulation in students to promote their academic success and lifelong learning. Differentiated learning and the use of atomic model materials offer promising approaches for enhancing student self-regulation and engagement. However, further research is needed to fully understand the complexities of these factors and their interactions.

## CONCLUSION

Based on the results of the research and analysis that has been carried out, it can be concluded that there is no significant positive relationship between differentiated learning and self-regulation. The relationship between these two variables is negative, which means there is no relationship between the application of differentiated learning and students' self-regulation profiles. Therefore, it can be said that the hypothesis in this study is rejected. Additional analysis was carried out regarding the student's self-regulation profile in each aspect. Based on the results of this analysis, the self-testing and concentration aspects had the highest scores with the most good scores obtained.

This study, while providing valuable insights, has several limitations, including a relatively small sample size, a single-institution setting, a cross-sectional design, and the reliance on self-report data. To address these limitations and gain a deeper understanding of the relationship between differentiated learning, atomic model material, and student self-regulation, future studies should consider larger sample sizes, multiple institutions, longitudinal designs, mixed methods, and intervention studies. By incorporating these improvements, future research can contribute to a more comprehensive and nuanced understanding of the factors that influence student self-regulation in the context of differentiated learning and atomic model material.

The implications for further research are being able to reveal the relationship between the application of differentiated learning and students' cognitive psychological conditions. This can be done by expanding the research subject and using both formative and summative assessment scores to describe the scores for the application of differentiated learning received by students. Apart from that, there is no need to limit material, considering that it takes a long time to be able to see the relationship between a learning process and students' regulatory conditions.

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**Add references again, at least 30 journal.**


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