The relationship between self-regulated learning and student learning outcomes in applied mathematics courses

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Received: 7 July 2023; Revised: 7 October 2023; Accepted: 8 October 2023

Abstract: This study aims to ascertain whether there is an interaction between self-regulating rules and student learning outcomes in applied mathematics courses. This study uses the product-moment correlation method from Karl Pearson. The research sample of 57 students was determined by convenience sampling. The data were obtained from questionnaires and midterm math scores. Data analysis methods use descriptive percentages, basic tests for linear regression, and SPSS version 16.0 for hypothesis testing. The findings of this research indicate that self-regulation has a solid and beneficial impact, correlated with the results of student learning in applied mathematics courses. The result of the calculation is the coefficient $r_{xy} = 0.721 > 0.005$, with a determinant of 51.98%. The greater the degree of self-regulation, the more significant the learning outcomes obtained by students in applied mathematics courses.

Keywords: Applied mathematics course; Learning outcomes; Self-regulated learning


INTRODUCTION

The global health crisis caused by the COVID-19 pandemic has had a significant effect on various sectors of life, including education. Efforts to reduce the spread of the virus have forced universities and educational institutions around the world to face new challenges in organizing teaching and learning processes. In this context, distance education has emerged as an important solution to maintain the continuity of education without compromising the safety of all parties involved (Sukardi, 2017). Since the stipulated COVID-19 as a National Disaster by the Indonesian government (Pemerintah Indonesia, 2020). As one of the policies issued by the government as a measure to avoid the virus's spread and transmission, all universities are using online classes. Online lectures are a learning process that uses interactive media as a liaison between students, lecturers, and material resources. Own online lectures have been explained in Law no. 12 of 2012, Specifically, the remote the use of in the process of teaching and learning multiple communication tool (Marsudi, 2021). 2012's Law No. 12 relating to higher education is a law that regulates higher education in Indonesia. One part of this law that is relevant to the distance teaching and learning process is Article 56A, which talks about distance education. Distance education is a form of education that is carried out by utilizing information and communication technology and other media to convey learning material to students who do not have to be present in the same place or physical space as the teacher. This allows the process of instruction and learning without requiring a direct physical presence in class (Ningrum et al., 2020).
Basically Pemerintah Indonesia, (2012) provides a legal basis that recognizes and regulates information and communication technology use in the teaching regarding the academic process in higher education. This legislation, higher education institutions in Indonesia can employ different communication media, include the Internet, videos, e-learning platforms, and the like, to carry out remote teaching and learning processes (Ningrum et al., 2020). In an excerpt of this circular, it is stated that the purpose of the Learning From Home (BDR) program is to ensure that all students have access to educational services during the COVID-19 period, to protect members of educational units who are in conflict from COVID-19-related hazards, to prevent the spread of incidents related to COVID-19 among participants, and to ensure the protection of all students from psychological harm (Winata, 2018).

Currently, the main goal is to bring the COVID-19 test to a more conducive condition while remaining committed to improving the education system. Safety and health at birth in order to execute learning from home in line with the principles, the primary concerns are for students, instructors, school principals, and all other members of the education unit (Winata, 2018). Politeknik Negeri Jakarta is one of the institutions that transitions online lectures from home. At the moment, though covid-19 cases have decreased, the online lecture process is still done, especially in theoretical courses such as Applied Mathematics (Handayani et al., 2021). Of course, in implementing online lectures, it is undeniable that there are limitations to distance and communication between lecturers and students, which will be a learning challenge in itself. One of them is that student learning outcomes must still show optimal results, even with the online learning process (Santrock, 2020).

During online learning, even though their names are displayed, there are very few students who with their own awareness to activate the on camera feature on zoom as proof of their readiness to learn. Based on the results of research conducted (Arifin, 2023). This happens because some students are studying while doing other activities such as playing games, helping parents, attending organizational meetings, etc., reducing discussion forums, and studying anywhere. In addition, learning activities carried out online do not make them more disciplined in attending lectures, such as there are still those who are late in joining and often do not enter. When a question and answer or discussion related to defense is conducted, only a few students are active in answering. Likewise, when given quizzes with the exact same material as those in the module, most students still get low scores (Arifin, 2023).

One of the characteristics of learning in tertiary institutions is student-centered, as stated in Permenristek No. 44 of 2015. Article 11 paragraph 1 contains the elements of the learning process listed in Article 10 paragraph (2) letter a, namely, interactive, holistic, integrative, scientific, contextual, thematic, efficient, collaborative, and student-centered elements. According to the article, student-centered learning is intended to mean that the learning process in tertiary institutions prioritizes the development of student independence in the pursuit of knowledge. One way to view independence in learning as a learning principle that can determine effective learning, namely the ability of students to manage learning activities, control learning behavior, and recognize their own educational demands, also known as Self-Regulated Education (SRL). Students that demonstrate a high level of self-regulation (SRL) in learning will be diligent in learning, continue to study without feeling hopeless, and can set aside items that can obstruct learning activities (Ellianawati, 2021).

SRL is the design and careful self-monitoring of cognitive and affective processes in completing a related academic task. According to Hendriana and Soemarmo (2014), three elements are included in the concept of SRL, namely: (1) Individuals create their own learning based on their own wants or goals, referring to an approach or learning method known as "self-directed learning" or self-based learning. This concept emphasizes the active role of individuals in taking the initiative to organize and direct the learning process according to their personal needs and goals. (2) People implement their learning programs and select their own tactics, and then refer to the process by which individuals are actively involved in planning and carrying out their own way of learning according to preferences, learning styles, and personal goals; and

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**References**


Ellianawati, 2021.

Hendriana and Soemarmo (2014).

Soemarno (2014).


Winata, 2018.
(3) People assess and compare their own learning progress to predetermined benchmarks. Individuals take responsibility for their own learning process by regularly monitoring the extent to which they have achieved their learning goals, assessing their learning outcomes, and comparing their achievements with criteria or established standards. SRL is more of a process of self-direction in transforming their mental abilities into academic skills, namely where individuals take their cognitive, creative, and critical thinking abilities and apply them into skills that are relevant to an academic or educational context. This involves turning abstract or conceptual thinking skills into concrete actions that can be used in a learning environment (Sugiyono, 2018).

At the tertiary level, learning necessitates greater independence and self-discipline from pupils in managing their time and learning processes, ensuring that they have enough time to study, participate in social activities, and maintain a balance in their lives. Being independent in learning means that they must decide how to plan learning and look for information about learning materials. Additionally, flexibility is a must for students, organize, and control themselves, including when facing dense lecture activities and difficult course assignments, by developing the ability to overcome academic challenges and find solutions when facing difficulties in understanding material or completing assignments. Therefore, it takes an active and independent effort by students to help them direct the learning process to the goals they want to achieve, this is referred characterized as learning that is self-regulated. Zimmerman & Martinez-Pons, a professor who introduced the theory of self-controlled education, define learning that is self-regulated as a level where participants actively bring behavior, motivation, and metacognition into the learning process (Eva, 2017). Metacognition is awareness and way of thinking; motivation is the encouragement that appears within oneself; and the actions they take to enhance the method of education. Thus, it might be understood that SRL has an important role in learning, namely to regulate oneself so that the learning process becomes more effective and independent (Hendriana et al, 2014).

Based on previous research that has been carried out, when it comes to self-regulation (self-regulation) as a predictor of learning outcomes in vocational high school students, the results of self-regulation have a favorable and substantial effect on student learning outcomes, this is shown by 20% of students who have moderate grades and 45% of students who have almost low scores, based on this information, student learning outcomes are said to be lacking or low, self-regulation with three existing dimensions and measured by seven indicators getting an average result of 1.77. From the results of this study, students only got an average self-regulation result of 1.77, with a number of students who had quite low learning outcomes of 45%, this shows that the self-regulation ability of students of SMK 1 Sangkuriang CImahi is be on low self-regulation ability as well. In this study, it is known pupils with poor test scores regulation will have relatively low learning outcomes. In this study, researchers are interested in discussing more about self-regulation and whether someone who has high regulation will get high learning outcomes. To strengthen the results, in this research, researchers will disseminate questionnaires, whether there are high regulatory results for students who have high learning outcomes (Friskilia, 2018).

Considering the previous description, researchers are eager to learn more about the connection of self-regulation to student learning outcomes, which are expected to help students improve the learning process. The research hypothesis is that There is a connection between self-control and and learning outcomes. The initial suspicion This study found a substantial connection between learning results and self-regulation. From all the explanations above, it will be explained in the results of the research (Arifin, 2023).

METHOD

Researchers used associative research methods in solving problems in this study. It's because associative research is a strategy for determining the association between two or more variables so that it can determine how variable X affects variable Y. This research was
conducted at the Jakarta State Polytechnic in the civil engineering department. The learning outcomes in question are learning outcomes that are measured based on the outcomes of formative assessments or assessments completed after a subject has been completed taken from midterm exam scores in the form of numerical data or numbers and final semester exams for applied mathematics courses for the 2021–2022 school year. In selecting the sample using the convenience sampling method, namely collecting the required data from available respondents, the researcher chose the sample based on proximity and did not consider whether the sample represented the entire population or not. In this study, variable X is SRL, variable Y is Student Learning Outcomes. The learning outcomes in question are learning outcomes that are measured based on the outcomes of formative assessments or assessments completed after a subject has been completed taken from the midterm and final semester exam scores for applied mathematics courses for the 2021-2022 academic year. Self-Regulated Learning (SRL) in this study was measured using a scale. The Likert scale was the sort of scale utilized in this investigation, the questionnaire made was taken from the indicators that have been described through aspects of self-regulation. Questions made based on the grid in the Table 1.

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Indicators</th>
<th>Item Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacognition in self-regulated learning</td>
<td>1. Students' ability to plan their studies</td>
<td>24, 27</td>
</tr>
<tr>
<td></td>
<td>2. Setting goals in learning</td>
<td>6, 29</td>
</tr>
<tr>
<td></td>
<td>4. Monitor yourself in learning</td>
<td>7, 14, 26, 34</td>
</tr>
<tr>
<td></td>
<td>5. Self-evaluation in learning</td>
<td>17, 42</td>
</tr>
<tr>
<td>Motivation in self-regulated learning</td>
<td>1. Self efficacy</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2. Self-attribution</td>
<td>36, 44</td>
</tr>
<tr>
<td></td>
<td>3. Interested in intrinsic tasks</td>
<td>9, 37, 46</td>
</tr>
<tr>
<td>Behavior in self-regulated learning</td>
<td>1. Choose an environment that optimizes learning</td>
<td>41, 43</td>
</tr>
<tr>
<td></td>
<td>2. Structuring an environment that optimizing learning</td>
<td>45, 47</td>
</tr>
<tr>
<td></td>
<td>3. Creating an environment that optimizes learning</td>
<td>13</td>
</tr>
</tbody>
</table>

The research instrument used was an online questionnaire. Questionnaires were sent to respondents using the Google form with distribution via the WhatsApp message group, respondents filled out the questionnaire within the time specified by the researcher, where students who had completed filling out the questionnaire confirmed via message in the group provided. The total number of respondents who filled out the questionnaire was 57 out of 57 respondents who were invited to fill out the questionnaire that had been provided.

Instrument reliability testing this study used the Alpha Cronbach method to conduct its analysis because the answers given by respondents were on a scale of 1–5. The stages of calculating the reliability test used the Alpha Cronbach technique, while to find out whether the instrument was valid or not, the instruments to be tested for validity were distributed to informants. Use the SPSS version 16.0 application to do a straightforward linear regression test, analyze the outcomes of a simple linear regression test, and draw conclusions based on the collected data also the outcomes of a straightforward linear regression test.

Meanwhile, to express the size of the contribution of the variable \(X\) to \(Y\), it can be determined by the term coefficient Formula 1.

\[
KP = r^2 \times 100\% \quad (1)
\]

Where, \(KP\) = The magnitude of the determining coefficient (determinant) and \(R\) = Correlation coefficient.
This research uses research procedures by collecting all data obtained through self-regulated-learning questionnaires as well as student UTS and UAS scores, transforming student questionnaire answer results from qualitative data to quantitative data namely, by making a questionnaire where the sample can answer questions with answers based on the Cronbach Alpha scale in the form of a scale of 1–5, conducting percentage descriptive analysis on each variable indicator and student learning achievement, categorizing the outcome of percentage descriptive analysis, conducting simple linear regression tests and hypothesis testing with the assistance of the SPSS version 16.0 software, analyzes the outcome of simple linear regression tests and hypothesis tests, makes conclusions based on collected data and simple linear regression test results and hypothesis test results. This study uses simple linear regression because it has two variables: the x variable, or self-control, which serves as the independent variable, and the y variable, or the dependent variable, namely learning outcomes.

RESULTS AND DISCUSSION

Results

Self-regulated learning variable X

The self-regulation score data was obtained by the distribution of a questionnaire to the sample. To determine the categories of high, medium, low, and low, researchers use level (ordinal) categorization. Based on the results of a self-regulation questionnaire from 57 first-year students of the Civil Engineering Department's Road and Bridge Design Engineering Study Program of PNJ for the 2021-2022 Academic Year in applied mathematics courses, Table 2 was obtained, which shows the analysis' findings by category.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>5.26%</td>
</tr>
<tr>
<td>Medium</td>
<td>39</td>
<td>68.42%</td>
</tr>
<tr>
<td>Low</td>
<td>15</td>
<td>26.31%</td>
</tr>
</tbody>
</table>

In Table 2, the results of student self-regulation are generally in the moderate classification namely, 68.42% or 39 students, low classification is 26.31% or 15 students, and 5.26% or three others are in the low classification.

Learning Outcomes variable Y

Data on learning outcomes scores were obtained by the distribution of a questionnaire to the sample. To determine the categories of high, medium, low, and low, researchers use level (ordinal) categorization. The results of the analysis statistics on learning outcomes are included in Table 3.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>34</td>
<td>59.96%</td>
</tr>
<tr>
<td>Medium</td>
<td>8</td>
<td>14.03%</td>
</tr>
<tr>
<td>Low</td>
<td>15</td>
<td>26.31%</td>
</tr>
</tbody>
</table>

In Table 3, it is found that student learning outcomes are generally in the high classification, namely 59.96% or 34 students, the low classification is 26.31% or 15 students, and 14.03% or three others are in the medium classification.

Normality Test

Furthermore, data analysis will be carried out in the form of the Kolmogorov-Smirnov normality test on self-regulation and student learning outcomes in the research sample. If the p-value for the normality test is greater than 0.05, the data are normally distributed. The overall result of the normality test for the data group is shown in Table 4.
Based on the Kolmogorov-Smirnov test calculation results, the significance value (Sig) of self-regulation was obtained by 0.321 and the learning outcome of 0.23 was bigger than 0.05. Therefore, the data on self-regulation and learning outcomes in this investigation, the data were evenly distributed.

**Linearity Test**

The purpose of the linearity test is to assess whether or not there is a substantial linear relationship between the two variables. A linear relationship between variable X and the data should exist, or self-regulation, and variable Y, or learning outcomes. The data in Table 5 is a summary of the linearity test's findings.

Based on the results of the SPSS calculation, the significance result (sig.) of 0.24 is superior than 0.05. Then it can be concluded that significantly the two variables are linearly related.

**Hypothesis Test**

The next experiment in the research used product moment correlation to test a hypothesis. The results of the hypothesis test are shown in Table 6.

The analysis's criterion is that if \( r_{xy} \) or \( r_{count} \) is more than \( r_{table} \), then \( H_1 \) is accepted and \( H_0 \) is rejected; if \( r_{xy} \) or \( r_{count} \) is less than \( r_{table} \), then \( H_0 \) is accepted and \( H_1 \) is rejected. \( H_0 \), or the null hypothesis, asserts that there is no link between the variables x and y; \( H_1 \), or alternatively the working hypothesis, asserts that there is a relationship between the variables x and y. While using the Table 7 of interpretation to compare the price of \( r \) to its value.

**Table 4. Normality Test Results**

<table>
<thead>
<tr>
<th>Data</th>
<th>p-value</th>
<th>Significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Regulation</td>
<td>0.321</td>
<td>0.05</td>
<td>Normally Distributed</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>0.23</td>
<td>0.05</td>
<td>Normally Distributed</td>
</tr>
</tbody>
</table>

**Table 5. Linearity Test Results**

<table>
<thead>
<tr>
<th>Data</th>
<th>p-value</th>
<th>Significance</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Regulation</td>
<td>0.24</td>
<td>0.05</td>
<td>Linear</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: processed from research data, 2022

Based on the results of the SPSS calculation, the significance result (sig.) of 0.24 is superior than 0.05. Then it can be concluded that significantly the two variables are linearly related.

**Table 6. Hypothesis Test Results**

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
<th>Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Regulation</td>
<td>1</td>
<td>.721**</td>
<td>57</td>
<td>.000</td>
</tr>
<tr>
<td>Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td></td>
<td>.721**</td>
<td>57</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 7. Interpretation of the Value Correlation Coefficient r**

<table>
<thead>
<tr>
<th>Coefficient Intervals</th>
<th>Relationship Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 – 0.199</td>
<td>Very low</td>
</tr>
<tr>
<td>0.20 – 0.399</td>
<td>Low</td>
</tr>
<tr>
<td>0.40 – 0.599</td>
<td>Enough</td>
</tr>
<tr>
<td>0.60 – 0.799</td>
<td>Strong</td>
</tr>
<tr>
<td>0.80 – 1.000</td>
<td>Very strong</td>
</tr>
</tbody>
</table>
Inferred from Table 7's findings is that, at a significance level of 0.05, the p-value is 0.721, indicating that there is no link between the variables self-regulated learning (X) and learning outcomes (Y). These findings suggest that $H_0$ is rejected and $H_1$ is accepted since the p-value is $0.721 > 0.05$. It is possible to draw the conclusion that there is no connection between self-regulated learning and learning outcomes based on the analysis results in this study.

The correlation value is known to be 0.721, and then the coefficient of determination is calculated by stating that $r^2 \times 100\%$ is the correlation coefficient value. The results obtained by the coefficient of determination, which is 51.98%, state that variable $X$, namely self-regulation, and variable $Y$, namely learning outcomes, have a relationship of 51.98%.

Discussion

According to the findings of their studies, there is a connection between student learning outcomes and self-regulated learning. It can be seen that the greater the self-regulation in a person, the higher the learning outcomes that will be obtained by the individual. This can happen because the ability to set learning goals, organize, self-evaluate, and have motivation is very necessary in the teaching and learning process. The results obtained in this study are in accordance with study by previous researchers, such as (Rahayu et al., 2017). The study's findings indicate a connection between self-regulation and student accomplishment. Furthermore, research carried out by Hanis et al. found that exists a relationship between self-regulation and cognitive learning outcomes in students (Ningrum et al., 2020). Furthermore, research conducted by Anita et al. shows that self-control can enhance students' academic performance (Nurdianasari, 2020). Students with strong self-control tend to have good learning outcomes. Therefore, the ability of students to arrange their studies can help them achieve better student learning outcomes in applied mathematics courses, setting goals, managing, monitoring, evaluating, and increasing self-motivation in learning (Permendikbud No. 109, 2013).

Politeknik Negeri Jakarta is one of the institutions that transitions online lectures from home. So far, even though Covid-19 cases have decreased, the online lecture process is still being carried out, especially theoretical courses such as Applied Mathematics.

Sed on the observations of researchers, during this online learning, even though their names are displayed, but very few students with their own awareness to activate the on cam feature on zoom as proof of their readiness to learn. In addition, learning activities carried out online do not make them more disciplined in attending lectures such as there are still those who are late in joining and often do not enter. When a question and answer or discussion related to defense is conducted, only a few students are active in answering. When given assignments, students tend to do assignments with almost the same pattern. Even When given quizzes with the exact same material as those in the module, most students still get low grades (Nurdianasari, 2020).

From the findings in the field, it can be strengthened by research results that demonstrate that self-regulation and student learning results are positively and significantly correlated in applied mathematics courses. The correlation coefficient ($r_{xy}$) of 0.721 demonstrates this.

Product moment correlation tests were utilized in this study's hypotheses testing. To ascertain if self-regulation and the learning results of first-year students in the Road and Bridge Design Engineering Study Program, Department of Civil Engineering PNJ for the 2021/2022 Academic Year, This study's thoughts is that there is a link between self-regulation and learning outcomes. The result of the product moment correlation calculation in this study $r_{xy}$ of 0.721, based on a significant table (sig) of 0.721 including the category of intense relationship level, then $H_0$ was condemned and $H_1$ was accepted (Inayah et al., 2021).

It is evident from the coefficient of determination calculation results that the final coefficient of determination is 51.98%, stating that variable $X$ is self-regulation and variable $Y$ is learning outcomes. There is a relationship of 51.98%, which is in line with research conducted by Yasdar & Muliyadi (2018). The result is that self-regulation exercises can increase student...
learning independence and discipline. This is consistent with studies that have been done by academics, namely that when a person has high self-regulation, he will be able to maintain discipline in learning so as to get high learning outcomes. Other studies have found that students who are used to being disciplined will make the best use of their time at home or at school so that they will show their readiness for the learning process at school (Purwaningsih & Herwin, 2020).

CONCLUSION

This study has a significant impact on self-regulation and learning outcomes. The findings revealed a favorable link and strong impacts of self-regulated learning on the learning outcomes of first-year students of the Road and Bridge Design Engineering Study Program, Department of State Polytechnic of Jakarta, Civil Engineering, Academic Year 2021–2022, in applied mathematics courses. The proportion of the connection between student learning results in applied mathematics courses and self-regulated learning is 51.98% of 100%, while 48.02% is influenced by other aspects not included in this study.

The researcher hopes that future researchers who want to research the connection between self-regulated learning and academic success will be able to expand and choose more research samples. It aims to increase effectiveness in examining the relationship between cell-regulated learning and learning outcomes. Because with high self-regulation in mathematics education, students will also get high learning outcomes.

Declaration

Author Contribution: EE: Conceptualization, Writing - Original Draft, and Formal analysis; DN: Data Curation, Investigation; AZA: Formal analysis, Investigation; RA: Writing - Review & Editing.

Funding Statement: -

Conflict of Interest: The authors declare no conflict of interest.

Additional Information: Additional information is available for this paper.

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