The Application of Problem-Based Learning with STEM Approach to Practice Students' Self-Regulated Learning on Renewable Energy Topic

B A Savana[1], A D Lesmono[1]*, and R D Handayani[1]
[1]Physics Education Department, Jember University, Jember, Indonesia
*Email: albert.fkip@unej.ac.id

Abstract. The 21st-century era is an era of rapidly advancing technology and information that transforms the learning paradigm into student-centered learning, implying that the students are supposed to be actively participating in the learning process rather than the teacher. Educators must facilitate students to study independently to attain academic excellence in self-regulated learning (SRL). This study aims to analyze students' self-regulated learning abilities in applying problem-based learning with the STEM approach on the subject of renewable energy in high school. This type of research is descriptive quantitative with the purpose to describe the data of the research results. The research was conducted at SMAN 1 Jember in class X.11. The SRL ability comprises six indicators including non-dependence on others, having self-confidence, behaving in a disciplined manner, having responsibility, behaving on their initiative, and having self-control. The research results indicate that students have a high ability of SRL which amounted to 76,4%.

1. Introduction

The 21st-century era is an era of rapidly advancing technology and information that transforms the learning paradigm into student-centered learning, implying that the students are supposed to be actively participating in the learning process rather than the teacher (Imaroh *et al*, 2021). Students also hold an essential part in learning, including determining what to learn, when to learn, and how to learn, and have complete responsibility towards their learning activities, hence they take responsibility for their learning from the beginning, thus enabling them to become independent (Tarumasely, 2021). Educators must lead the students to be able to study independently. In addition, students should be trained in the learning process to achieve self-regulated learning (SRL) following their learning experiences (Febriyanti and Imami, 2021).

Schunk and Zimmerman (2012) stated that SRL is a systematic student learning process that directs thoughts, feelings, and actions toward achieving goals. SRL is the ability of students to regulate themselves in learning or also known as independent learning. SRL emphasizes a person's ability to organize and control themselves, particularly when dealing with tasks (Zamnah, 2019). Learning outcomes are things that relate to learning activities as learning activities are a process, consisting of all the psychological domains that occur as a consequence or as an impact of students' learning experiences and processes in school classrooms (Nabillah and Abadi, 2020). According to Khotimah (2016), learning outcomes are the abilities that students possess after receiving learning experiences in the learning process. The fact that occurs in the field is that students' SRL is considered quite low (Ansori and Herdiman, 2019). This is proven by the lack of learning initiatives and student achievement as stated in Kurnia and Warmi's research (2020). Furthermore, Oktaviani *et al* (2020) said that students' learning outcomes are still relatively quite low, this shows that low learning outcomes are influenced by several factors, including the lack of discipline and motivation to learn in students.

Yulianti *et al* (2016) found that through SRL, students became proficient in regulating learning and could improve their learning outcomes. This phenomenon establishes a foundation that reinforcement of self-efficacy in organizing students' learning activities needs to be strengthened more than educators. Students who are practicing SRL are responsible for their own learning time, such as regularly preparing assignments and obtaining learning resources from multiple sources, which requires students' SRL to be trained and improved (Subekti and Kurniawan, 2022).

In addition to receiving knowledge, students are also required to be actively involved in learning and one of the steps is the application of the appropriate learning model following 21st-century education (Haryanti, 2017). Problem-Based Learning is a learning model that has an essential element of presenting authentic and significant issues by teachers for students that serve as a means of conducting investigations and inquiries (Rerung *et al*, 2017). The PBL learning model has several advantages, including practicing students' real-world problem-solving skills and assessing their own learning progress, and through discussion activities, students are taught to have high curiosity and good communication skills (Rahayu and Ismawati, 2019).

One of many factors that influence the success of education is the implementation of learning approaches that adapt to changing times (Kemdikbud, 2021). An example of the 21st-century learning approach is the Science, Technology, Engineering, and Mathematics (STEM) approach. Lestari *et al* (2018) stated that STEM provides good impacts. The essence of STEM is an approach that integrates science, technology, engineering, and mathematics in learning to encourage students to reason, analyze, solve problems, create, and use technological products in learning (Kemdikbud, 2021).

Human beings cannot escape from energy. Up to now, the major proponent of energy requirements has been petroleum, which is increasingly scarce and expensive (Arsana *et al*, 2018). The Ministry of Energy and Mineral Resources (ESDM) in 2018 reported that Indonesia's petroleum reserves are dwindling and only have sufficient for the next 9-10 years. By depleting fossil energy sources, there has been a shift from the utilization of non-renewable energy sources to renewable energy sources, thus the necessity to utilize and maximize the potential of renewable energy (Al Hakim, 2020). Renewable energy is energy that comes from renewable energy sources, which can be used indefinitely and is inexhaustible because it is recoverable (Azhar and Satriawan, 2018). The wealth of energy resources in Indonesia such as solar, wind, water, geothermal, and others can be used as alternative energy to replace fuel oil (Yuliati *et al*, 2022).

2. Methods

This study is quantitative descriptive research that describes the condition of the subject or object of research based on the facts as they appear or as it is systematically, accurately, factually, and detailed using the research stages with quantitative approaches (Yusuf *et al*, 2017). In addition, the method used is the survey method, which is a process of taking samples of a population and using a questionnaire as a primary data collection instrument. The independent variable in this study is the PBL model with the STEM approach that contains the following steps according to Sari *et al* (2022): identification of the problem, collection of the necessary data, research stage, transferring and designing, and communication. Whereas the dependent variable in this study is SRL ability containing modified indicators from Hidayat *et al* (2020), which are non-dependence on others, having self-confidence, behaving in a disciplined manner, having responsibility, behaving on their initiative, and having self-control. The SRL data results were analyzed according to the questionnaire results through the five likert scales as a scoring guideline as shown in Table 1 given below.

Table 1. Likert Scales Assessment Score Guidelines

Assessment	Description	Score	
		Positive	Negative
SS	Strongly Agree	5	1
S	Agree	4	2
KS	Disagree Less	3	3
TS	Disagree	2	4
STS	Strongly Disagree	1	5

After being analyzed on a likert scale, it is then classified based on the classification list of students SRL assessment score intervals in Table 2 as follows.

Table 2. Interval Classification of Assessment Score

Interval Percentage	Category
80% - 100%	Very High/Very Good
60% - 80%	High/Good
41% - 60%	Enough
21% - 40%	Low
0% - 20%	Very Low

3. Results and Discussions

The SRL data analysis results were collected according to questionnaires, observation guidelines, and interviews. The indicators used to analyze students' SRL skills consisted of six indicators modified from Hidayat et al (2020), which are non-dependence on others, having self-confidence, behaving in a disciplined manner, having responsibility, behaving on their initiative, and having self-control. From the data analysis, it is known that students' SRL is in the high category. The percentage of each indicator is as follows.

Table 3. Students' SRL percentage of each indicator

Indicator	Percentage	Average Total Percentage
Non-Dependence on Others	77,17% (High)	76,4% (High)
Having Self-Confidence	76,83% (High)	
Behaving in a Disciplined Manner	72,67% (High)	
Having Responsibility	80,13% (Very High)	
Indicator	**Percentage**	
Behaving on Their Initiative	73,6% (High)	
Having Self-Control	72,9% (High)	

a. Non-Dependence on Others

This category indicates the average percentage of this category is high, the thing pointing out this category is high is the age of Senior High School (SMA) children who enter the early adolescent age (13-17 years) begin to find self-identity during this period, they often feel entitled to make their own decisions, they also try to solve their problems so that at this developmental period the achievement of independence and student identity is particularly prominent (Diananda, 2018). Students are trying to solve problems by thinking deeply and are not easily affected by other people's opinions (Ananda *et al*, 2020).

b. Having Self-Confidence

The average percentage in this category is in the high category, things that show this category is high are when students are always calm about doing everything, have good potential and abilities, and have sufficient intelligence (Kartianti, 2019). Students do not feel inferior if they have to be different

from others and feel confident in their abilities, and can make the best possible use of time for learning (Ananda *et al*, 2022).

c. Behaving in a Disciplined Manner

This category has a high average percentage, things that show this category is high are students have preparation before studying, as well as complying with rules, following teacher commands, and keeping an orderly record of the material presented by the teacher (Sari and Bermuli, 2021). Students also strive to work with diligence and discipline (Ananda *et al*, 2022).

d. Having Responsibility

In this category, the average percentage is high, what shows it is high is that students have well-prepared before studying, this is one of the characteristics of being responsible students (Sari and Bermuli, 2021). Students who take responsibility for their learning activities will certainly strive to do their assignments well and their achievement will be improved (Hastuti and Fuadi, 2018).

e. Behaving on Their Initiative

This category indicates the average percentage of this category is high, the thing pointing out this category is high as students can take the initiative to diagnose their learning needs, identify learning resources, formulate learning objectives, select and implement appropriate learning strategies, and evaluate their learning outcomes (Badjeber, 2020). Students with good initiative are capable of digging up information from various sources in addition to the teacher (Fajriah *et al*, 2019).

f. Having Self-Control

This category has a high average percentage, things that show this category is high are students are capable of managing time in studying and working independently, controlling things that can influence their willingness to learn, and evaluating the learning process and results (Badjeber, 2020).

According to the data analysis, students' SRL ability is in the high category, it is because the application of PBL-STEM in learning was able to train students' SRL thus students are capable of regulating their learning style and making it following Sulasmi's research (2017), that the learning would be effective and efficiently since students have proper preparation in terms of learning mastery and independence.

4. Conclusions

The conclusion obtained from the results and discussion mentioned previously is that students' self-regulated learning ability after applying problem-based learning with the STEM approach is in the high category.

References

[1] Al Hakim R R 2020 *J. Pengabdian Kepada Masyarakat (ANDASIH)* **1** 1.
[2] Ansori Y and Herdiman I 2019 *J. Medives* **3** 11.
[3] Ananda R, Yuliansyah M, and Handayani E S 2022 *J. Mahasiswa BK An-Nur: Berbeda, Bermakna, Mulia* **8** 1.
[4] Arsana I P J, Azis J, Nurwahdaniar M, Purnomo S, Sri S, and Syaiful B S 2018 *Perencanaan Prasarana Perkotaan* (Yogyakarta: Deepublish).
[5] Azhar M, and D A Satriawan 2018 *Administrative Law Governance J.* **1** 398.
[6] Diananda A 2018 *Istighna* **1** 116.
[7] Badjeber R 2020 *J. Pembelajaran Matematik. dan Sains* **1** 1.
[8] Fajriah L, Nugraha Y, Akbar P, and Bernard M 2019 *J.Educ*. **1** 288.
[9] Febriyanti F, and Imami A I 2021 *J. Ilmiah Edukasi Matematik*. **9** 1.
[10] Haryanti Y D 2017 *J. Cakrawala Pendas* **3** 57.
[11] Hastuti D D and Fuadi D 2018 *J. Managemen Pendidik.* **13** 139.
[12] Hidayat D R, Rohaya A, Nadine F and Ramadhan H 2020 *Perspektif Ilmu Pendidik.* **34** 147.
[13] Imaroh R D, Sudarti, and R D Handayani 2021 *J. Pendidik MIPA.* **12** 198.
[14] Kartianti S 2019 *Hibualamo: Seri Ilmu-ilmu Sosial dan Kependidik.* **3** 71.

[15] Kemendikbud 2021 *Optimalisasi Pendekatan STEM dalam Pembelajaran Abad 21*. Diakses dari https://ayoguruberbagi.kemdikbud.go.id/artikel/optimalisasi-pendekatan-stem-dalam-pembelajaran-abad-21/ pada tanggal 16 Oktober 2022.
[16] Kementerian ESDM 2018 *Laporan Tahunan Capaian Pembangunan 2018*. Jakarta: Direktorat Jenderal Minyak dan Gas Bumi.
[17] Khotimah K 2016 *Pengaruh Strategi Pembelajaran Terhadap Hasil Belajar Ditinjau Dari Aktivitas Belajar* (Surakarta: Tiga Serangkai).
[18] Kurnia D and Warmi A 2020 *Prosiding Sesiomadika* **2** 386.
[19] Lestari D, Astuti B, and Darsono T 2020 *J. Pendidik. Fisika dan Teknolo.* **4** 202.
[20] Nabillah T dan Abadi A P 2020 *Prosiding Sesiomadika* **2** 659.
[21] Oktaviani U, Kurniawati S, Apriliyani M N, Nugroho H dan Susanti E 2020 *MATH LOCUS: J. Riset dan Inovasi Pendidik. Matematik.* **1** 1.
[22] Rahayu R dan Ismawati R 2019 *Indones J. Natural Sci. Educ.* **2** 221.
[23] Rerung N, Sinon I, dan Widyaningsih S W 2017 *J. Ilmiah Pendidik Fisika* **6** 47.
[24] Sar U, Alici M, and Sen O F 2018 *Electronic J. Sci. Educ.* **22** 1.
[25] Sari S P dan Bermuli J E 2021 *J.Kependidik.* **7** 110.
[26] Schunk D H, and Zimmerman B J 2012 *Motivation and Self-Regulated Learning: Theory, Research, and Applications.* Routledge.
[27] Subekti G M T, dan Kurniawan R Y 2022 *J. Pendidik. Ekonomi* **7** 1.
[28] Sulasmi E S 2017 *J. Pendidik. Biologi* **6** 1.
[29] Tarumasely Y 2021 *J. Pendidik. Edutama* **8** 71.
[30] Yuliati T, Handayani T, dan Sellyana A 2022 *Community Development J.: J. Pengabdian Masyarakat* **3** 869.
[31] Yulianti P, Sano A, dan Ifdil I 2016 *J. EDUCATIO: J. Pendidik.Indones* **2** 98.
[32] Yusuf M, Fahmi I, dan Suwito 2017 *Metode Penelitian: Kuantitatif, Kualitatif, dan Penelitian Gabungan (4th ed.)* (Jakarta: Penerbit Kencana)
[33] Zamnah L N 2019 *ANARGYA: J. Ilmiah Pendidik. Matematik.* **2** 54.