

The Trend of Self-Regulated Learning Research on Physics Education

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ABSTRACT

Self-regulated learning has the potential to help optimize the effectiveness of physics learning. Therefore, research on self-regulated learning in physics education is vital. However, only limited studies exist on research trends related to this topic. For this reason, we are interested in capturing the characteristics of research about self-regulated learning in physics learning. This study was conducted to find out the characteristics of self-regulated learning in physics lessons and its future research directions. The literature review method was used to address the research objectives. The article search used the keywords 'Self-regulated learning' OR 'Self-directed learning' AND 'Physics', with the article's publication date limited to between 2012 and 2024. This study reviewed 12 articles from the Scopus database. This review found that self-regulated learning research in physics context is still very limited regarding methods, research variables/objects, and learning topics. Physics topics that have been researched include heat, dynamic fluids, and atomic physics. This result indicates that there are still wide opportunities for studies on self-regulated learning in physics with variations in methods, research variables/objects, and learning topics. This research is expected to contribute insights regarding the characteristics of self-regulated learning studies on self-directed learning in physics education context and its future research opportunities.

Keywords : Trend, Self-regulated learning, Physics Education, Physics, Review.



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I. INTRODUCTION

Self-regulated learning is an essential skill for learners to support lifelong learning. Self-regulated learning, or in other terms called self-directed learning or autonomous learning, can be interpreted as a process or competence where learners can independently organize and motivate their learning [1]. This definition shows that self-regulated learning can refer to a competency or a learning strategy. Self-regulated learning is important because it can help learners become lifelong learners and independent professionals [2]. In addition, these abilities can support self-development and learning participation, increase self-reliance, and help learners master a skill or expertise [3], [4]. The discussion on self-regulated learning roles shows that it can benefit students' learning outcomes.

The significant contribution of self-regulated learning in instruction indicates the potential for applying this ability in physics instruction. Self-regulated learning is increasingly important in physics learning because there are still many problems experienced by students in physics learning, including the limited ability of some students such as problem-solving [5], critical thinking [6], [7], to the low understanding of concepts in various physics topics [8], [9]. In fact, the abilities that arise from learning physics are very important to develop and Physics itself is an important topic of discussion at the high school level, and universities major in science and technology.

The above explanation shows that self-regulated learning, both as an ability and a part of the learning process, can encourage student learning achievement, especially physics learning. Therefore, self-regulated learning studies are necessary to ensure empirical confirmation of the advantages of self-regulated learning in physics education. In this context, the researcher is interested in reviewing the trend of self-regulated learning studies in physics education. This study was conducted to capture the characteristics of self-regulated learning

studies in physics education and future research orientation. Through this study, an outline of the most recent research characteristics in the area of self-regulated learning can be used to investigate the topic in the future.

II. METHOD

The literature review is used to address the goals of this research. The literature review used in this research adheres to the method by [10], which consists of (1) deciding on the theme of the study, (2) performing a thorough literature search, (3) analyzing and synthesizing data from the literature, and (4) writing an article review. The reviewed literature in this study was sourced from the Scopus database. The articles were searched using the keywords “Self-Regulated Learning” OR “Self-Directed Learning” and “Physics” and were limited to the range of 2012-2024. The search yielded 14 articles, with 12 articles reviewed in this study, and 2 articles were excluded because the researcher could not access them. The literature-seeking and exclusion steps are depicted in Figure 1.

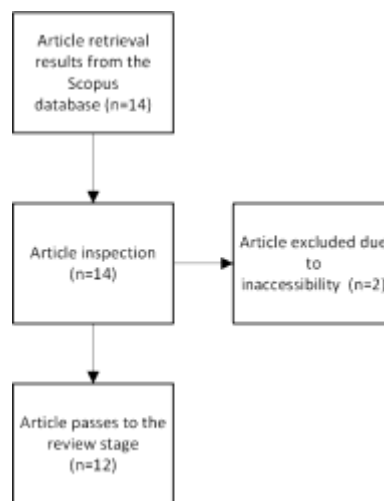


Fig. 1. Diagram of the literature selection process

III. RESULTS AND DISCUSSION

This study examines 12 articles concerning self-regulated learning in physics education. Six of the articles are conference proceedings, while the other six are journal articles. In this study, two main keywords were used: self-directed and self-regulated learning. Both phrases refer to the same term. Self-regulated learning can be perceived in two ways: as part of a learning strategy [11] and learner behavior [12]. The analysis of the references we found is provided in Table 1.

Table 1. Results of literature analysis

No.	Article	Method	Findings
1	[13]	This study is an R&D research study to develop an instrument to measure whether a student is a self-regulated learner. The participants were university students. The analyses used include EFA and CFA analyses, as well as effect size with Cohen's d index and t-test.	This study successfully produced a valid and reliable instrument. The measurement results showed no significant change in self-regulated learning as a function of time. In addition, personality, based on the Big Five Inventory, has a relationship with self-regulated learning.

No.	Article	Method	Findings
2	[14]	This research is descriptive. The methods used include questionnaires, interviews, and documentation. The participants were new students from the chemistry and physics departments who took introductory physics courses.	The results showed that self-regulated learning had been implemented well, although it has not fully supported problem-solving skills. The main problems that cause this are teachers' and students' lack of competence and unpreparedness for technology.
3	[15]	This research is an R&D study to develop teaching materials. The participants in this study were university students from 12 regions in Indonesia. The analyses used included ANOVA and N-Gain.	The developed teaching materials are proven to be practicable and effective in improving students' self-directed learning.
4	[12]	This research is a descriptive study involving university students during school closures due to COVID-19. The data analysed is the click-stream data of students on the module's online learning platform. Analysis was conducted by modelling linear equations, ANCOVA, and non-parametric tests.	Campus closure changed students,, planning and goal-setting strategies for completing assignments but had no detectable impact on outcomes or time to completion and did not change students' self-reflective behaviour.
5	[16]	This research is a limited experimental study involving high school students in Bandar Lampung, Indonesia. The data analysis used the Mann-Whitney Test and effect size calculation.	The developed module is effective in improving students' understanding of the concept of fluid dynamics.
6	[17]	This research is a descriptive correlational study with a mixed methods approach. Research participants included principals, teachers, and secondary	There is a positive correlation between motivational strategies and learners' performance in physics learning. This variation in motivational strategies simultaneously contributes more than 70% to learning

No.	Article	Method	Findings
		school students. The analyses used included Cronbach alpha calculation, descriptive analysis, cross-tabulation, and ANOVA.	performance.
7	[18]	This study is descriptive research. It used surveys before and after learners learned certain strategies. The survey was used to capture data on learners' perspectives on self-regulated learning. The research participants were university students. The analysis method included descriptive analysis and a correlation test.	The level of self-regulated learning correlates with grades in physics class. Self-regulated learning is considered very helpful. Learners' learning strategies are different for high achievers, who tend to choose effective strategies, while low achievers tend to choose alternating strategies.
8	[19]	This research is descriptive research using the survey method. Participants were physics department students from Syiah Kuala University. Data were analysed descriptively.	Learners have moderate and high levels of self-regulated learning.
9	[20]	This experimental study used a one-group pretest-posttest design with junior high school students in Bone Bolango as participants. The analysis used N-Gain.	Science learning based on self-regulated learning is proven to improve science process skills, especially writing skills with moderate and high categories.
10	[21]	This study is a descriptive study with a survey design. Participants were high school students in Bursa, Turkey. Data were analysed using SEM.	Personal epistemology influences motivation, organisational strategies, critical thinking skills, and self-regulated metacognition. Students' knowledge about the source and development of knowledge contributes to self-regulated learning ability in physics learning.

No.	Article	Method	Findings
11	[22]	This study was an experimental study with a factorial design. Participants were form-4 students from peripheral schools.	This study revealed that the type of pedagogical agent did not have a significant impetus on performance in physics. However, in the context of Self-Regulated Learning (SRL), there were significant contributions to the organization and critical thinking dimensions when examined according to the type of pedagogical agent. Meanwhile, no significant distinction was found in practice, elaboration, and meta-cognitive self-regulation.
12	[11]	This is an R&D study. Participants were students at Indraprastha Giri University. The analysis used simple descriptive and inferential statistics.	The VIFOCA model is feasible for physics learning and has been proven to improve problem-solving skills.

The reference list in Table 1 contains 12 articles published in the period 2012 - 2024. The distribution of articles published each year in that period can be seen in Figure 2. Figure 2 shows that there is an increasing trend of research on self-regulated learning in physics learning indexed in the Scopus database. Even so, the number of researches each year amounts to at most 3 researches, namely in 2021. This shows that there is still a lack of research on this topic in the context of physics.

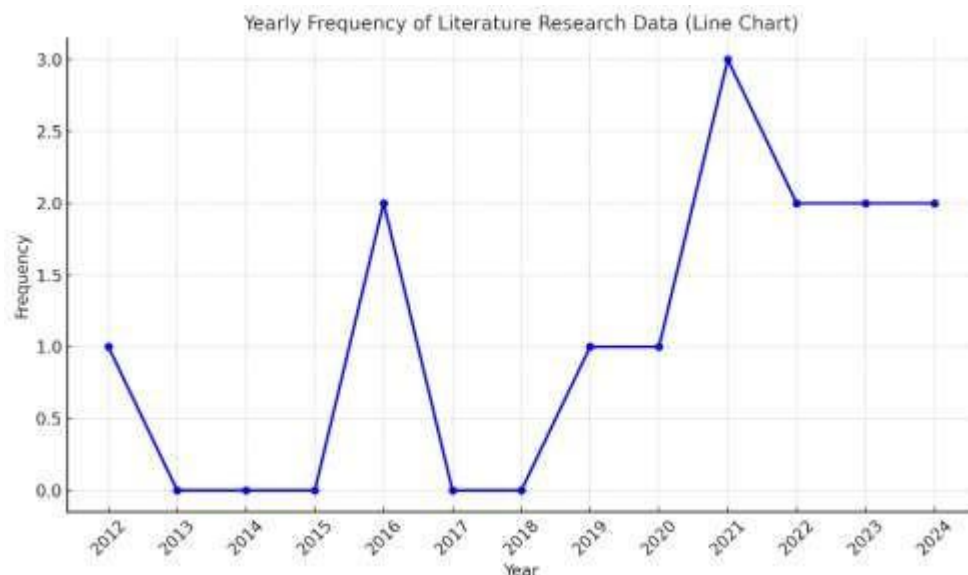


Fig. 2. Frequency of self-regulated learning research by year

The aforementioned research started with research questions/problem formulations. To answer these research questions, the methods used include experimental methods, descriptive methods, and R&D. The distribution of the types of research used can be seen in Figure 3.

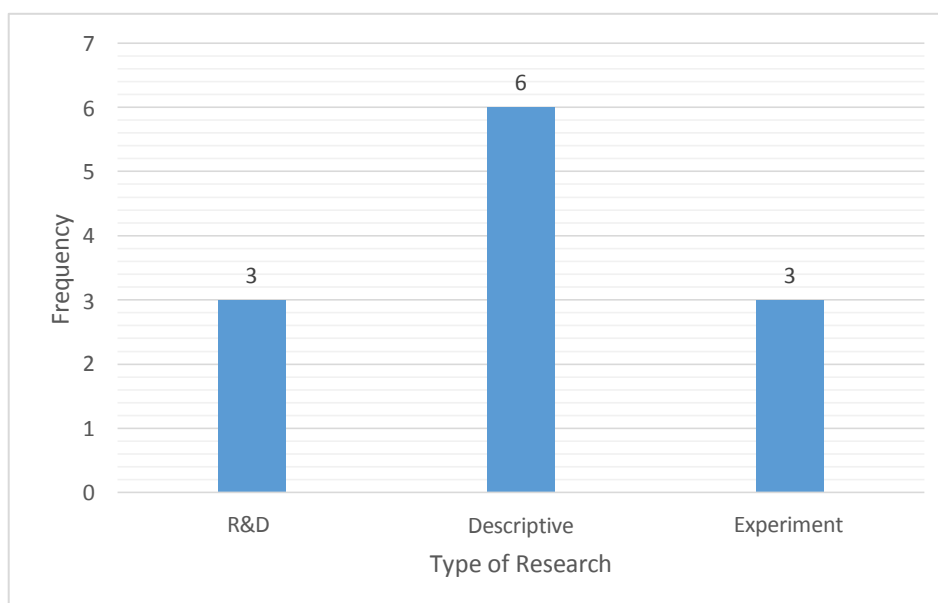


Fig. 3. Distribution of self-regulated learning studies in physics education depending on the research method used

Figure 3 shows that existing studies are still dominant in descriptive research. Existing research still focuses on the explanation of the way self-regulated learning behavior or process is expressed in physics lessons. Experimental or developmental research has not been widely studied to improve students' physics learning outcomes and optimize physics learning associated with self-regulated learning.

Descriptive studies about self-regulated learning in physics learning still depicts a limited phenomenon. The study mostly examines the relationship between self-regulated learning and problem-solving ability [14], self-regulated learning behaviour during school closings due to COVID-19 [12], identifying the level of students' self-regulated learning ability [17], [19], identification of learning strategies and performance of learners who have a level of self-regulated learning [18] and identification of relationships and learner strengths between personal epistemology, self-regulated learning, and learner learning outcomes [21]. Some examples of descriptive research outside physics learning and self-regulated learning include studies about teachers' perspectives on self-regulated learning-based learning strategies. [23] or student perspectives on self-regulated learning behaviour [24]. These examples are only a small part of the breadth of research opportunities in the context of physics learning.

Learning development associated with self-regulated learning in physics learning has a greater opportunity than descriptive research. Research with the type of R&D research associated with self-regulated learning in physics learning developed several products including assessment instruments [13], learning resources [15], and Learning Models [11]. Based on our findings, there are only 3 articles linked to self-regulated learning in physics learning. This means that the opportunity for R&D research is still very wide open considering the many types of assessments, media, learning resources, and learning strategies or models that can be developed.

In line with development research, experimental research concerning self-regulated learning in physics is still limited. The results of our review found that the existing experimental research is more inclined to examine the effect of self-directed learning-based models on concept understanding [16], the effect of self-regulated learning-based learning on scientific writing skills [20], and the effect of pedagogical agents on self-regulated learning and students' perceptions of pedagogical agents [22]. As for research outside physics learning that has been studied, for example, experiments on the effects of self-regulated learning on knowledge acquisition and collaborative skills [25] and academic performance [26]. This relationship between self-regulated learning and knowledge acquisition and academic performance suggests the need for self-regulated learning research in physics learning, considering that learners' performance varies for different learning content. In addition, the application of various physics learning methods and media to see the effectiveness of learning in improving self-

regulated learning on physics topics is also interesting to study. Furthermore, experimental research linked to self-regulated learning in physics learning for other research variables such as critical thinking, creative thinking, and higher-order thinking ability still has great research opportunities.

The research characteristics of the articles we examined can be grouped into student and non-student participants. Figure 4 shows the distribution of research for each participant. Less than 10 per cent of the research involved non-student participants. Some non-student participants included the principal and teachers [17]. For research with students as participants, the distribution of research is presented in Figure 5. In Figure 5, it can be seen that university students are the most common research subjects, with limited research involving secondary school-level students (high school, junior high school, form-4). However, Figure 5 also shows that there is no research involving elementary school students. This may be because the subject of physics is not explicitly taught in primary school. However, there are actually many physics topics that have been taught at the primary school level, such as the concept of sound [27] and the concept of electrical circuits [28]. Research related to self-regulated learning is still very much possible at the primary school level. If we look further, self-regulated learning from the perspective of developmental psychology is developed by learners from an early age to support their lives [29]. This may indicate that differences in self-regulated learning characteristics were observed at different levels of human development. The description shows that there is still a need for research with non-student participants, secondary school students, and primary school students.

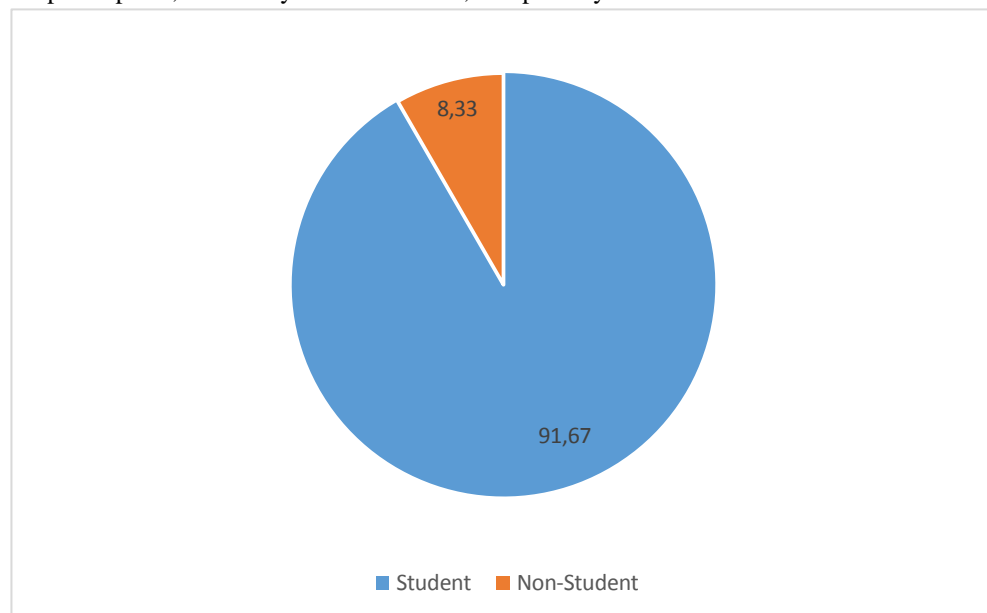


Fig. 4. Pie chart of the composition of research involving students and non-students

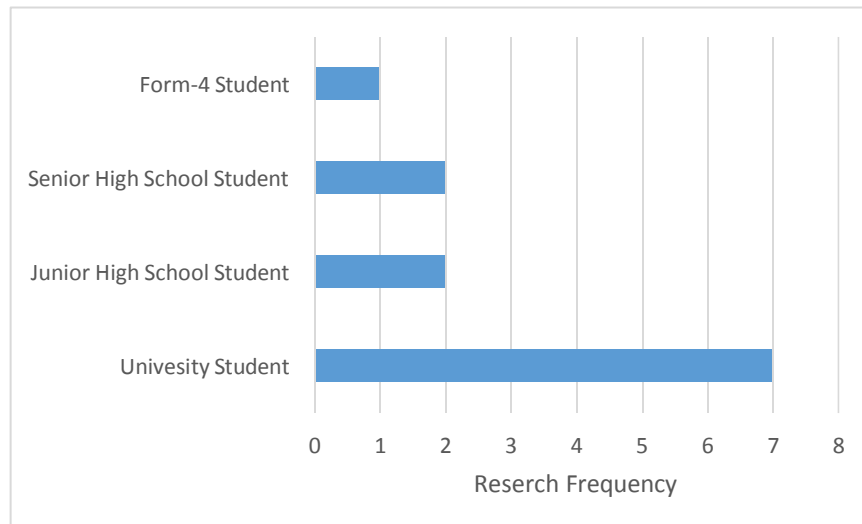


Fig. 5. Distribution of the quantity of research for each student's education level

The description of research associated with self-regulated learning in physics learning shows that there is still limited research concerning self-regulated learning in physics learning. Of the 12 existing articles, only 3 articles mention self-regulated learning in specific materials, namely atomic physics [15], fluid dynamics [16], and heat [20]. In fact, some research shows that self-regulated learning is a context-dependent variable, especially for contexts such as the complexity of learning materials [30], [31]. This shows the importance of research on various physics learning topics. Research regarding other physics contexts will provide a richer treasure of knowledge for physics learning science.

IV. CONCLUSION

Based on the description in the results section, research about self-regulated learning in physics learning is still very limited for experimental, descriptive, and R&D research. The existing research mostly examine self-regulated learning mapping and the relationship among self-regulated learning with various variables such as critical thinking ability, concept understanding, writing ability, and pedagogical agents. The physics materials studied are also mostly general, and only 3 articles are specific to certain topics. Research also mostly portrays students as research subjects. These limitations show the breadth of future research opportunities associated with self-regulated learning in physics learning, such as research with teacher subjects, R&D research, and experimental and descriptive research for other research variables such as critical thinking ability and creative thinking ability.

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