Elementary School Students' Self-Regulated Learning in A Virtual Laboratory Activity

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Abstract. Self-Regulated Learning is an ability students must have to restructure their learning activities. Through restructuring, students can internalize their learning goals to be more focused and optimal. Students who are not able to evaluate and monitor their own learning, in order to compensate, allow others to regulate their learning or rely on the assistance of others to complete a task successfully. This research describes the actual conditions of 5th-grade elementary school students' self-regulated learning in virtual practicum activities. This research involved 100 students from private elementary schools in Bandung. The method used in this research is pre-experimental design. The instrument was a questionnaire adopted from the MSLQ with 57 statement items with four choices ranging from strongly disagree to strongly agree. This research shows that students' learning regulation abilities in PhET-assisted virtual practicum learning are low. The practical implications of this research highlight the importance of training students' learning regulation skills consistently and continuously.

Keywords: Self-Regulated Learning, Elementary School Students, Virtual Laboratory.

1 Introduction.

Not every school in Indonesia is affiliated with the laboratory to do practicum activities. Some schools should find an alternative due to the lack of laboratory facilities. Since the pandemic, teachers and students have become familiar with online learning and laboratory activities or virtual practicum. Currently, virtual laboratories are also starting to become an alternative science learning activity in many elementary schools. Virtual laboratory activity is an interactive science simulation that students complete online from their personal devices. The concept of virtual practicum is to provide persistent, consistent, and flowing interaction from users with material that can eliminate confusion caused by verbalism. This kind of activity, with all its advantages and disadvantages as online learning, also provides new psychological challenges. This challenge arises because online learning activities have very different characteristics from conventional learning [1]. Based on the definition, online learning is interactive learning

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carried out by teachers and students that involves information and communication technology in the interaction process [2].

The effectiveness of online learning is not only determined by how much information is given to students and the feedback given by teachers but is determined by many more complex things, such as the availability of precise instructions, appropriate technical equipment, and easy access, as well as the potential to increase motivation and support. For students in online learning, teachers should use various alternative applications to support this goal [3]. In online learning activities, students are theoretically fully responsible for setting learning goals, managing study time, how long learning takes, and evaluating their performance [1], [4], [5]. In an ecosystem that frees students to learn like this, students' ability to manage the learning process regarding when, where, and how becomes one of the critical abilities that must be possessed [6]. Not a few students feel overwhelmed when carrying out virtual practicums using applications. The lack of information but the abundance of features often confuses students when carrying out virtual practicums. Apart from that, the temptation to try other practicums is enormous so that it can waste students' learning time. In this case, students face learning activities that are more complex than conventional practicums. To help students minimize the problems they face when carrying out virtual practicums, previous studies on Self-Regulated Learning topic explain that student learning outcomes can be achieved effectively, both in online and offline learning, positively through support for the development of Self-Regulated Learning aspects [1], [4], [6]–[9].

Solving complex problems in learning activities, whether structured in the classroom or unstructured outside the classroom, requires knowledge, motivation, and common sense to analyze one's condition and the learning environment to develop achievement strategies. solving problems faced by students [8], [10]. The motivation and common sense referred to, as well as the learning arrangements described by Kizilcec et al. [11], refer to the concept of Self-Regulated Learning (SRL), which has been described previously. Self-regulated learning is defined as an independent process that is supported by self-confidence to activate students in changing their mental abilities into academic performance abilities such as determining learning goals, choosing learning strategies, and self-monitoring [4], [10], [12]. Unlike the general problem-solving perspective, which focuses on metacognition and deductive conclusion-making, Self-Regulated Learning also shows the importance of self-confidence and affective reactions that arise during learning activities [10]. Self-Regulated Learning is like the glue that manages learning activities from planning to evaluation, as well as a pacing tool that can help students manage learning activities generally and personally. Personally, it relates to students' ability to manage their feelings always to be motivated in learning, and in general, to deepen their skills in using tools to support learning activities such as face-to-face applications, gadgets, and computers to carry out learning activities and seek help from friends, teachers, and learning resources. From the internet when experiencing a deadlock [13]. Several previous studies stated that self-regulation is the key to student success in academic aspects [7], determining the level of motivation and commitment to learning [6], as well as encouraging students' efforts to solve complex problems in each learning activity [8].

Self-regulation in the academic field refers to regulating thoughts, feelings, and actions intended to achieve specific learning goals, such as analyzing reading material, preparing for exams, or working on independent assignments [14]. Researchers found that students who are not able to evaluate and monitor their own learning, in order to compensate, allow others to regulate their learning or rely on the assistance of others to complete a task successfully. The results of previous research also show that the implementation of the Self-Regulated Learning theory is used to increase the effectiveness of learning that is considered complex and requires a long time to complete, such as the Inquiry learning model as well as practicums, either carried out directly at school or with the help of electronic media. [15]–[19]This is to the statement that the theory and application of Self-Regulated Learning used in solving complex problems in learning activities, whether carried out in a structured manner in the classroom or unstructured outside the classroom, does not only require knowledge but also motivation and reason. It is healthy to analyze one's condition and the learning environment to develop strategies for achieving solutions to problems faced by students [19], [20]. The motivation and common sense referred to and the learning arrangements described refer to the concept of Self-Regulated Learning (SRL), which is a solution to complex and straightforward learning problems [11]

2 Methods

This research was carried out using a pre-experimental method with a sample of 100 students from four classes in grade 5 at one of the private elementary schools in Bandung, taken based on a purposive sampling technique. Of the 100 students, 50 students from 2 classes will be conditioned to carry out virtual practicum individually, and the other 50 students will do practicum in groups with 4-5 students per group. Generally, teachers use PowerPoint as a learning medium. Neither students nor teachers at this school have experience in online practicum activities using virtual practicum applications. Based on reports from subject teachers, most students study independently at home because both parents are busy working.

The instrument used was the Motivated Strategies for Learning Questionnaire (MSLQ) questionnaire, which was adapted from the results of Duncan & Mckeachie's research [21], PhET interactive simulations on the concept of changing the shape of objects, screen recording applications, and devices or computers. The reliability of the questionnaire was calculated using SPSS 25, which produced a figure of 0.873 in the reliable or outstanding category [22]. Students respond to each statement on the questionnaire using a 4-point Likert scale ranging from "strongly disagree" to "strongly agree". The height of the score indicates the level of Self-Regulated Learning of the research sample [1]. Questionnaires were given to all research samples after students carried out learning activities. Data is obtained through questionnaires and the analysis results of virtual practicum videos sent by students to get a comprehensive picture of students' Self-Regulated Learning. The following image shows student activities while carrying out learning activities.

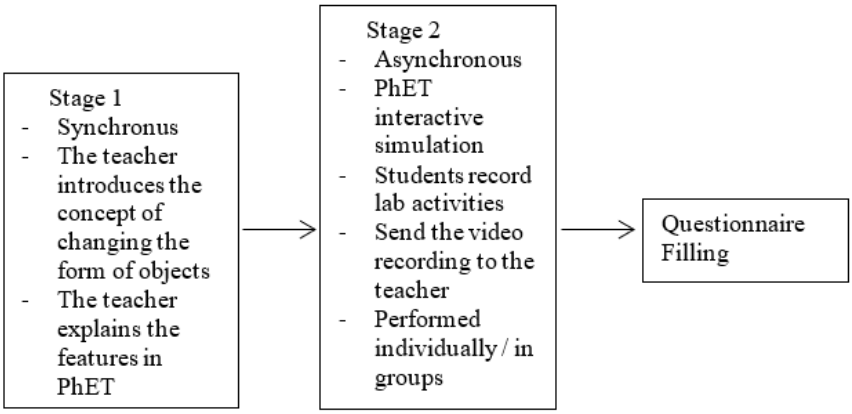

Fig 1. The flow of student learning activities

Because lesson activities are limited to a maximum of 2X40 minutes, teachers usually use their time to provide explanations of the concepts being studied without discussion sessions to pursue achievements in conveying concepts. To get around this, learning activities are carried out in 2 stages. Learning activities that function to explain concepts are carried out synchronously. In contrast, virtual practicum activities are carried out asynchronously using a cellphone or computer with the help of screen recording applications such as AZ Recorder, Freemaker, Camtasia, or the default screen recording application on students' devices. This practicum-recorded video functions as a Trace methodology or an instrument used to observe the cognitive processes used by students when completing assignments or learning activities [23]. The data obtained was processed and analyzed descriptively quantitatively by calculating the average and percentage of each item per stage.

3 Results and Discussion

Based on the stages, Self-Regulated Learning can be assessed from three student learning phases: the initial thinking process (forethought), performance, and self-reflection [20]. The work process in the initial thinking phase includes two categories, namely task analysis and self-motivation processes. The task analysis stage aims to determine goals and strategies for achieving them, as well as students' efforts to motivate themselves by activating their interest in what will be learned and the expectations that arise after students carry out these learning activities. In the performance phase, student self-regulation is categorized into control activities and self-monitoring. This category relates to students' efforts to work on, understand, and describe their learning activities. The performance phase also includes students' efforts to obtain a depiction and understanding of concepts and to remain focused on learning activities even though they are carried out without support or assistance from the teacher. The final phase is self-

reflection; this phase is related to the evaluation of learning performance and the affective reactions that arise after students carry out learning activities, which are described as follows;

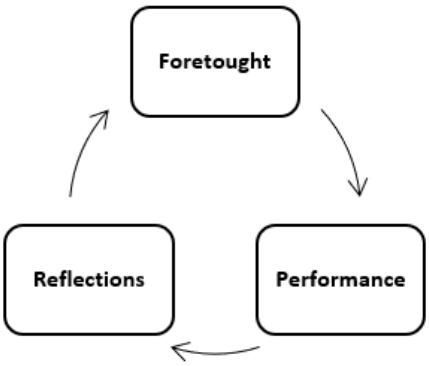

Fig 2. Self-regulated learning cycle

Table 1. Data on students' regulatory abilities in the initial thinking aspect

Indicator	Student response (%)			
	Strongly agree	Agree	Disagree	Strongly disagree
Determine goals	26.0	1.9	34.6	39.4
Determining Strategy	2.9	18.3	55.8	24.0
Hope	1.9	8.7	51.9	38.5
Self-assessment	1.9	18.3	60.6	21.2
Worry	16.7	34.6	38.5	10.9
Self-efficacy	5.8	17.3	52.9	26.0
Average	9.2	16.5	49.0	26.7

The forethought stage is crucial when students determine the learning goals to be achieved. Determining learning goals, designing learning activities, measuring one's abilities, and setting expectations for achieving learning goals will increase student optimism and commitment as transformative actions that make goals more concrete and achievable[24]. Table 1 shows that, in general, students have not been trained to carry out aspects that, according to Self-Regulated Learning theory, need to be implemented before students carry out learning. This is normal because, based on previous research, it is known that teachers in elementary schools assume that students are not yet able to

learn or determine the direction of learning independently, so students' learning regulation skills have never been trained before [25].

Table 2. Data on students' regulatory abilities in performance aspects

Indicator	Student response (%)			
	Strongly agree	Agree	Disagree	Strongly disagree
Metacognition	5.0	25.8	53.5	17.7
Repetition	2.9	26.9	51.9	20.2
Elaboration	5.8	21.8	59.6	14.7
Help-seeking	3.8	16.0	59.6	21.8
Average	4.4	22.6	56.2	18.6

In the Performance aspect, students are expected to be able to analyze learning objectives, determine learning strategies, and determine outcome expectations. Based on these three activities, students are expected to find out which parts they think are difficult to do, then create a priority scale for activities, reorganize work according to the priorities set, and try to seek help from friends, teachers, or parents if students cannot find a solution on the challenging session. However, based on Table 2, it can be seen that students have discomfort in doing repetition, elaboration, or seeking help, where based on interviews conducted with ten respondents, all of them agreed that they felt confused when doing virtual practicum at home. Furthermore, respondents explained that they felt excited about doing the virtual practicum. However, they did not understand the purpose and essence of the practicum even though they had been provided with student worksheets. So, when students experience confusion, they choose to stop rather than seek help or answers to the problems they find. Another aspect that also disturbs students in carrying out virtual practicum independently at home is the distraction of message notifications and notifications from video-sharing applications that they often watch. These notifications will immediately break your concentration and if the information from the notification is interesting. The more attractive the message in the notification, the faster students will switch the screen from the virtual practicum application to another application.

In this aspect, many activities theoretically need to be practiced so that students can overcome cognitive learning problems, such as focusing on themselves, determining learning strategies, and choosing time and place. All of these activities need to be carried out so that within the learning time, students can focus on completing their learning even though there are distractions from aspects outside of learning.

Table 3. Data on students' regulatory abilities in the reflection aspect

Indicator	Student response (%)			
	Strongly agree	Agree	Disagree	Strongly disagree
Evaluation	9.9	25.3	73.7	16.0
Evaluation	15.0	35.2	54.7	20.6
Average	12.5	30.3	64.2	18.3

The reflection aspect of Self-Regulated Learning theory is related to students' ability to compare learning outcomes with the goals achieved [24]. Theoretically, students are expected to be able to compare the recorded results with the objectives that have been prepared and assess the quality of work progress by comparing the stages of the task with the stages currently being implemented. Based on the results of student reflection, it is hoped that students will be able to analyze how failure or success occurs and what the determining factors for both are. This can be done by reviewing recorded or experimental results to understand process errors or the smooth implementation of learning to understand the causes of failure or successful task completion. So that in subsequent learning, students can repeat factors that help learning and eliminate factors that lead to failure. However, the questionnaire results in Table 3 show that students do not understand the function of reflection, so there is no reflection process in the independent learning activities that students carry out. Based on the recordings that students made, students only did one practicum to fill in the practicum worksheet according to observations. Students do not feel the need for repetition to get other observation results even though, for example, in the practicum, changes in the shape of objects occur when they apply too much pressure to the tube so that the tube explodes. The molecules scatter out, as in the following picture.

Fig 3. Screenshot of student virtual practicum activities

Virtual practicum aims to facilitate students with knowledge gained through an independent investigation process [26]. One of the keys to successful online learning is students' active participation in physical and mental activities during learning activities. Independent investigations carried out by students need to involve students as learners in planning, implementing, and reviewing the activities that have been carried out. The potential of virtual practicum by maximizing the use of visuals allows various types of

learning rather than just using textbooks; apart from that, even without paying attention to what the teacher teaches, the visual information received by students can consistently increase their understanding of the instructions given by the teacher [27]. In virtual practicum, existing limitations make students use alternative conceptions to create alternative explanations that cannot be obtained from the application. Apart from that, it was found that students who studied with virtual practicum tended to use shallow thoughts to provide an explanation of what they saw. Students who work with virtual practicum feel satisfied more quickly because they feel they have found the correct answer to the practicum activity. In contrast, students who learn using real practicum tend to have a more profound conception of finding the answer to what they see [28]. This is also reflected in the activities of students who tend not to work according to the initial explanation given by the teacher. In the synchronous learning activities in class, the teacher explained that they needed to observe water molecules. However, the students' screenshots showed that they randomly observed the molecules available in the PhET virtual practicum feature.

The results of this research support Govender's findings [29], who found three essential aspects that should not be ignored when teachers assign students to do virtual practicums. 1). Habituation and training. Students cannot simply be released to carry out the practicum independently on the first try, even though the teacher has explained the concepts that will be studied in the practicum and introduced the features of the virtual practicum. Based on the data collected, students generally work randomly, intending only to fill in the worksheets given by the teacher. This familiarization and training will be a critical process to equip students to carry out online learning independently, which has more significant challenges than conventional classical learning [19], [29]. 2nd aspect). Students' regulatory abilities in learning. As the center of learning activities, students need to consciously understand the goals and strategies they will carry out in the learning process by using virtual practicum independently. The existence of forethought, performance, and reflection stages will make virtual learning more meaningful for students. In addition, with students' learning regulation abilities, learning activities become more structured, and students know what must be done when encountering difficulties. 3rd aspect). is the visualization provided by the virtual practicum. Virtual practicums do not always provide benefits for students; in virtual practicum, it is not uncommon for existing limitations to encourage students to use alternative conceptions to create alternative explanations that cannot be obtained from the software. Apart from that, it was found that students who studied with virtual practicum tended to use shallow thoughts to provide an explanation of what they saw. Students who work with virtual practicums feel satisfied more quickly because they feel they have found the correct answer to the practicum activity. In contrast, students who learn using real practicums tend to have more profound conceptions of finding answers to what they see [28]. this finding is proven by the way students explain what they say. Students who learn using virtual practicums fill in students' worksheets precisely what they observe in the application; this happens because computers are programmed to provide everything students want to see so that students tend to be passive respondents to the messages given, and these messages seem to have little meaning and relevance outside the program because continuous activity with the same format cannot produce

connections stored by the brain, whereas to be successful in studying science, students need the ability to connect ideas and develop meaning [30]. Furthermore, it was also explained that the most limiting aspect of learning with computers is that there are few opportunities for students to test, make mistakes, and learn from these mistakes in order to develop the ideas they are constructing in learning activities. So, to avoid minimal exploration by students, teachers need to enrich this virtual practicum with learning models that support students' active exploration.

4 Conclusion

The research results show that students' learning regulation abilities are low in all aspects. The reflection aspect is the aspect with the highest response compared to other aspects, even though it is not consistent with the results of student screen recordings. Analysis of the causes of students' low ability to regulate learning includes their lack of training and habituation in regulating their learning activities, limited implementation of virtual practicums in the classroom, and the influence of learning models to support student exploration activities. The implications of the findings require the importance of integrating SRL in learning activities, which is preceded by teacher training to design and integrate SRL in learning activities.

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