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# Student Self-Regulated in Remote Learning With the Implementation of Local Virtual Lab Based on Online Tutorial (LVL-BOT)

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**ABSTRACT**

This study aims to measure the level of Self-Regulated Learning (SRL), conceptual understanding and identify an increase in conceptual understanding after using LVL-BOT. This type of research is Pre-Experimental with One-Group Pretest-Posttest Design. The research sample consisted of 37 students from physics classes who took modern physics courses. Students' level of Self-Regulated Learning is administered using a questionnaire, and understanding of concepts is administered using a test. Based on the analysis results, the percentage level of Self-Regulated Learning is at a value of 87.7%, which is included in the very high category. There is a significant difference between the mean pre-test and post-test mean. The N-Gain Values of Photoelectric Effect and Black Body Radiation are 0.47 and 0.57, respectively. This shows an increase in student's conceptual understanding, which is "enough" after using LVL-BOT.



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## I. Introduction

The coronavirus pandemic has had a significant impact on human life in all fields, especially in education. Learning that was initially carried out face-to-face is now being carried out online to cut the spread of the coronavirus. At present, all educational institutions are trying to find suitable models and methods. Distance learning does not interfere with student learning, and the concept remains easy to understand even though it is done online.

The separation of physics between students and lecturers is a characteristic of far-reaching education [1]. This impacts the lack of interaction between students and lecturers. Of course, it has a negative effect on student learning outcomes. Lecturers cannot control student activities during the distance learning process. There are still many lecturers who do not teach due to limited skills in operating computer technology. Besides that, lecturers are also not used to developing online-based teaching materials.

For this reason, it is necessary to use technology to support broader interactions and activities for students and lecturers [2]. This technology is also expected to present engaging, easy, and meaningful learning and the ongoing impact of the Covid 19 pandemic and advances in network-based Information and Communication Technology (ICT) in education. So, ICT in supporting distance learning is a must, and the government, educational institutions, and lecturers need to develop appropriate models, methods, and technology media.

In addition, one indicator in seeing the achievement of distance learning objectives is the level of understanding of students' concepts. Learning achievement has a relationship with the student's SRL level. Students with a low level of learning independence tend to have an inadequate understanding of concepts and vice versa [2], [3]. SRL is closely related to students' planned thoughts, feelings, and actions, significantly affecting their learning and motivation.

Distance learning in various majors or courses is undoubtedly different. In social learning, the material presented in presentation slides or learning videos is sufficient. This is different from the science and mathematics majors, especially physics. Physical phenomena that can be understood by mastering mathematical concepts first become quite difficult. They must be trained how to solve problems with a good understanding of mathematics. In addition, physics students must understand and observe directly existing physical phenomena and study these phenomena with correct mathematical concepts. Learning like this will be more interesting, not dull, and increase student activity. Therefore, physics learning should involve direct experimentation [4], [5]. However, not all physical phenomena can be observed by conducting experiments because some abstract material and invisible [6], [7]. In addition, the implementation of the experimental method is currently not possible due to several factors, such as (1) during the pandemic, which requires learning to be carried out in individual homes; (2) the availability of equipment in the laboratory that students in their homes can use is minimal [6], [8]; (3) the absence of practicum guidelines developed by lecturers that can direct students to make observations self-regulated is also a big problem for physics learners during the pandemic [9].

Students who use distance learning are autonomous learners who have freedom of behavior and the learning system they will do [2]. They have broad autonomy to determine when they learn, where and how to organize their learning process and what learning resources should be used. This is different from face-to-face learning, where the lecturer can regulate the teaching and learning process in the classroom. In addition, because the characteristics of each student are different in the distance learning process, their ability to manage the learning process both in distance classes and additional learning is of particular concern for the teaching staff. Choosing the suitable physics learning method during the distance learning class is expected to increase student motivation and activity in learning. This will also significantly affect their independence in learning physics.

Self-Regulated Learning (SRL) for students in distance learning is very important. They must be able to control and regulate the learning process. They are also expected to direct their learning positively [2], [10]. The use of communication technology is expected to be more widely used in accessing information and learning resources. Therefore, the role of lecturers in this matter is very much needed. The types of technology and teaching materials provided by the lecturers certainly affect their learning independence. Lecturers who do not understand the technology and cannot use it either in developing learning media or the teaching and learning process will affect distance learning. It is necessary to have technology-based teaching materials that can achieve learning objectives.

There need to be learning techniques that can direct students to explore abstract concepts even though learning is carried out online to solve this problem. This technology is also expected to increase students' understanding of these concepts, reduce misconceptions and improve skills in analyzing graphics, numbers, or complete with mathematical concepts. This technology can replace the use of physics practicum tools, is easy to use, and has no risk even though it is used outside the supervision of a lecturer or tutor. One of the right technologies to solve this problem is implementing a Local Virtual Laboratory Based on Online Tutorial (LVL-BOT). Various previous studies have used virtual laboratories as a substitute for experimental activities in the classroom. However, there is still very little to do in online learning because the virtual laboratory needs to be developed to be used easily by students wherever they are. So that with the additional application, it can direct students in using teaching materials.

The problem in this study is how students' level of learning independence and increased understanding of concepts before and after using LVL-BOT.

## II. Theory

A local virtual lab is a developed application tool capable of describing a real laboratory environment. This application is stored in technology devices such as computers, laptops, or smartphones that the user can access offline. Several studies on the use of virtual laboratories have been conducted. According to Yusuf and Widyaningsih [11], virtual laboratories can improve critical thinking skills. In addition, students' activities and perceptions of learning physics with virtual laboratories are very good. Swandi *et al.* [12] also stated that virtual laboratories positively affected problem-solving skills and student learning outcomes. In addition, student activity observation is in the very high category, above 80% when learning with the experimental method using a virtual laboratory [6]. Most students also strongly agree with virtual laboratories because they feel invisible phenomena become visible even though they will never be seen [7]. Students who use virtual media such as virtual laboratories as learning media have a higher ability to understand and present the studied material [13], [14]. A similar conclusion was also put forward by Magyar and Žáková [15] in their research, which stated that students'


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motivation to be more active in participating in learning and developing various skills could be increased by using virtual laboratories. Figure 1 is an example of a virtual laboratory developed by Swandi *et al.* [12].

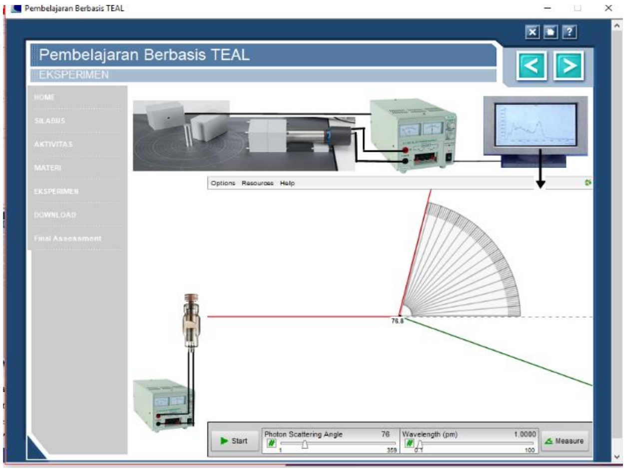


**Figure 1.** Local virtual laboratory equipment on the Compton effect concept.

The photons emitted from the x-ray tube then collide with free electrons on the surface of the gold. As a result of this collision, electrons will bounce off with various changes in angle, and photons will experience a change in magnitude. The change in magnitude after the collision is observed from the detectors that surround the Compton effect circuit. Various facilities can be used in this virtual experiment, such as changes in incident angle and photon wavelength to determine the relationship between the incoming photon wavelength and the angle of the electron after the collision, the relationship between the incoming photon wavelength and the photon wavelength after the collision, the photon wavelength shift after the collision, and the kinetic energy of the electron after the collision.

Although virtual laboratories have been widely developed and used by previous researchers, these studies indicate that virtual laboratories are used in the classroom (face-to-face between lecturers and students), which means there is still extensive and direct interaction between lecturers and students. This is different if learning is carried out remotely where students cannot meet directly with the lecturer. Without prior explanation by the lecturer, virtual laboratory learning will be very difficult to do. Therefore, lecturers need to develop virtual laboratory teaching materials that students can download with online tutorials to overcome this. This is important so that virtual laboratories can still be used without direct instruction from lecturers or tutors. In addition, virtual laboratories are also supported by online learning platforms through applications such as websites or e-learning. So that even though lecturers and students are separated, they can still interact even through the application. Students would benefit immensely from using instructional materials and media like this since professors provide instructions or video tutorials and a distance learning platform. When students have questions, they can quickly ask the lecturer [16]. Figure 2 shows the stages of learning using LVL-BOT.

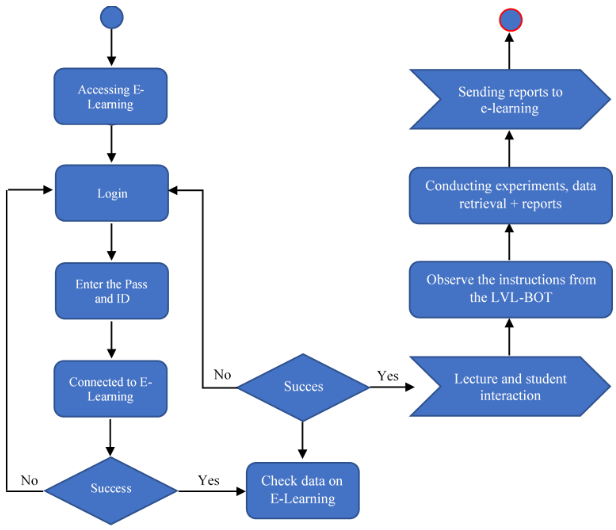


**Figure 2.** Learning stages using local virtual lab based on online tutorial

Two things distinguish LVL-BOT from virtual labs that have been widely used before. The first is the LVL-BOT supported by a video containing instructions from the lecturer. With this video, students easily follow instructions to make observations and collect data, then analyze the results and conclusions. The second advantage is that LVL-BOT is accessed with an online learning platform. This makes learning more interactive. The interaction between teachers and students can still be done supported by e-learning facilities. In addition, teachers easily evaluate the learning process that has been taking place [17].

LVL-BOT, which is rich in interactive simulations, allows students to carry out experimental activities independently whenever and wherever they are [18], [19]. An exciting simulation can show physics concepts and phenomena through visualization. Students can see how physical parameters influence or interact with a concept or theory [20].

## III. Method

This research is pre-experimental research where there are still external variables that influence students' conceptual understanding and learning independence. This is due to the absence of control variables, and the sample was not randomly selected. The sample in this study was 37 physics education students who took modern physics


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courses at Makassar State University. This study uses the One-Group Pretest-Posttest Design, as shown in Table 1.

**Table 1.** Research design [21]

| Pattern | Information |
|---|---|
| $O_1$ X $O_2$ | $O_1$ = Initial test scores before being given treatment<br>$O_2$ = Final test scores after being given treatment |

Students are first given a preliminary test before students are treated with virtual laboratory teaching materials assisted by e-learning in distance learning. Then, after being given treatment, students were again given the post-test. Thus the results of the treatment can be known to be more accurate because it can compare with the previous situation.

Experts have validated concept understanding test instruments and self-regulated learning questionnaires to assess construct and content validity. The test instrument is in the form of essay questions with ten questions related to the concept of the photoelectric effect and black body radiation concepts. Meanwhile, to promote self-regulated learning consists of 40 questions with five indicators, namely (1) initiative in online learning; (2) responsibility for assigned tasks; (3) confidence in the results of work; (4) independence in working and making decisions; and (5) independence in using knowledge and experience by situations and conditions.

Improved understanding of concepts after using a virtual laboratory based on video tutorials and assisted by e-learning is reviewed based on the average post-test score minus the average pre-test score. Improved learning outcomes were analyzed using N-Gain, student learning independence data were analyzed descriptively through percentage techniques.

## IV. Results and Discussion

At the end of the lesson, with the application of a virtual laboratory based on online tutorials on black body radiation and photoelectric effects, students are asked to complete a self-study questionnaire according to their opinion of themselves during the lesson. The questionnaire was filled out online via google form and then analyzed using Ms. Excel in a quantitative descriptive manner to calculate the percentage of responses. The results of the self-learning questionnaire analysis for each indicator are presented in Table 2.

Based on Table 2, in general, the percentage of self-regulated learning is at a value of 87.7%, which falls into the very high category. The indicator of self-regulated learning, namely student initiative in online learning, had the highest percentage, 92.4%. At the same time, the lowest is the indicator of self-confidence towards work results, namely 80.4%. For the other three indicators, the score is above 80%. In addition, it can be concluded that the percentage for all indicators of Self-Regulated Learning of students is in the very high category.

**Table 2.** Indicators of student self-regulated learning

| Aspect | Percentage (%) |
|---|---|
| Initiatives in online learning using LVL-BOT | 92.4 |
| Responsibility for assigned tasks | 91.6 |
| Confidence in the results of work | 80.4 |
| Behave in a disciplined manner | 91.8 |
| Independence in using knowledge and experience by situations and conditions. | 82.3 |
| **Average** | **87.7** |

The high percentage of student initiative in online learning is due to adequate online learning support facilities. All students have laptops and smartphones that can access teaching materials and virtual laboratories based on online tutorials. However, some students complained about the availability of their internet data packages and their unstable network. Because to access and download all teaching materials and virtual laboratory applications, a large data package is required. Some students have also prepared learning materials before the lecturers provide virtual laboratory teaching materials. Most of the students had studied the material beforehand with books and references from the internet.

Almost all students do assignments and collect on time. The task given is in the form of conducting experiments with a virtual laboratory. Each student studies the teaching materials provided, makes observations, collects data, analyzes, discusses, and draws conclusions. Students are happy with assignments that are quite clear and systematic. So they no longer need to ask the lecturer about completing the assignment. They also strongly agree with the task collection system that uses e-learning. The lecturer quickly checked the assignments that were entered then students were asked to correct them if there were deficiencies. However, a small proportion of students are still indifferent and cannot complete assignments self-regulated. They still need help from friends for the process.

Students find it easy to work and study with sufficiently complete teaching materials such as books, worksheets, and virtual laboratory manuals. Online tutorial-based virtual labs are beneficial for them. They argue that this is equivalent to face-to-face learning because a lecturer guides them to work on a project even though it is in the form of audio and not video. The learning material is also presented in audio format so that the explanation is obvious and can be repeated if there are things that are not understood. Some students who do not


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understand the explanation can also directly ask questions through the e-learning used. Some students also thought that their memory ability of the concepts they learned through virtual laboratories was better. This aligns with Jagodzinski and Wolski's research that learning using virtual laboratories positively impacts teaching efficiency. Students also experience an increase in remembering information and show greater resilience in remembering information (concepts material) [22], [23]. However, even though distance learning is becoming more attractive, many students still lack confidence in their results.

Even in a pandemic, students are encouraged to enhance their activities at home, which includes studying. For some students, this is not an issue. They argue that although face-to-face learning in class is different from distance learning, they have great freedom [24]. Supported by online tutorial-based virtual laboratory teaching materials, they can easily download and access teaching materials, manage when and wherever they study, repeat lessons repeatedly, and ask lecturers directly using e-learning without noticing other students. Therefore, it can be concluded that the application of online tutorial-based virtual laboratories is very suitable to support distance learning and increase student independence in learning. Several previous studies have shown that the application of laboratory-based teaching materials can improve student learning activities, attitudes, and motivation in learning physics [25], [26]. Amin *et al.* [5] also stated a positive relationship between the application of a virtual laboratory with problem-solving skills and science process skills for physics students. Palloan and Swandi [27] state that using virtual simulations with active learning strategies can increase student activity in observing abstract concepts.

After the students filled out the self-regulated learning questionnaire, they were then asked to take a final test related to black body radiation and the photoelectric effect. Concept understanding test scores were then analyzed to determine the average score on the pre-test and the final test, and then the intervals were determined. The results of comparing the results of the students' concept understanding test results before and after being treated in the form of the online tutorial-based virtual laboratory teaching materials on the photoelectric effect and black body radiation materials are described in Figure 3.

From Figure 3, it can be seen that there is an increase in the average understanding of students' concepts before and after learning using virtual laboratories for photoelectric effect material and black body radiation. For the photoelectric effect material, the difference between the final test and the pre-test is around the value of 27. For the black body radiation material, it is in the range of value 13. Although the difference between the final test and the pre-test is not too significant, it can be concluded that there is an enhancement of student concepts understanding using LVL-BOT. Categories of increasing students' conceptual understanding are tabulated in Table 3.

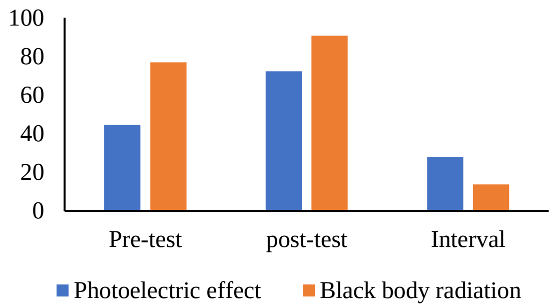


**Figure 3.** Comparison of pre-test and post-test

**Table 3.** The value and category of enhancement concept understanding

| Unit | N-Gain value | Category |
|---|---|---|
| Photoelectric Effect | 0.47 | enough |
| Black Body Radiation | 0.57 | enough |

From Table 3, it can be seen that there is an increase in student learning outcomes after using the LVL-BOT both on the concept of the photoelectric effect and black body radiation. At the same time, the increase is in the "enough" category.

These results are in line with several studies conducted by several researchers. Research conducted by Yusuf and Subaer [28] and Amin *et al.* [7] show that there has been an increase in student learning outcomes and science process skills after using virtual laboratories inside. According to Nurrokhmah and Sunarto [29], learning with a virtual laboratory makes learning activities more enjoyable. Students' interest and enthusiasm for learning can be increased by using virtual laboratories. Furthermore, this learning paradigm encourages students to be more engaged to absorb better the concepts being taught. Athaillah *et al.* [30] also stated an increase in student's conceptual understanding, marked by the N-Gain category in the experimental class and the control class for dynamic electricity material. Likewise, there is an increase in conceptual understanding for chemistry learning, especially in understanding, cognitive, and application after learning using a Local Virtual Laboratory Based on Online Video Tutorial (LVL-BOT).

Although there is an increase in student's conceptual understanding after learning using LVL-BOT, it cannot be concluded that the application of the LVL-BOT on conceptual understanding. This is because the form of research used is only pre-experimental, which does not limit other influencing variables.


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## V. Conclusion

Based on the study results, it can be concluded that the level of student self-regulated learning in distance learning physics after using the LVL-BOT learning device is at an average percentage of 87.7%, which falls into the ”very high” category. In addition, based on the analysis results before and after the use of LVL-BOT, there was an increase in conceptual understanding of both the photoelectric effect material and black body radiation, each of which was in the “adequate/enough” category. However, it cannot be said that using the LVL-BOT learning tool is both on self-regulated learning and on conceptual understanding. This is because the research design used does not limit other variables that may have an effect. Therefore, other researchers need further research that can be carried out by other researchers using experimental research designs such as the use of pre-test and post-test in two classes, namely the experimental class and the control class. Further research can also be carried out to see whether there is an effect of the application of LVL-BOT on learning independence and conceptual understanding or learning independence on conceptual understanding. Therefore, the use of research methodologies must be appropriate.

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