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Investigating Differences in Project Activities and Student Digital Literacy between Learning through Electronic Workbench and PhET Simulation

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ABSTRACT

Students' digital literacy is very urgent for online learning and requires learning activities for habituation. The purpose of this study was to investigate the comparison of project activity processes and digital literacy, between learning using electronic workbench and PhET simulation. This research method uses a quasi-experimental design, the sample consists of two groups, namely 29 students in the experimental group and 31 students in the control group selected through purposive sampling technique The data collection technique used a concept understanding test part of digital literacy, observation of the results of project activities and questionnaires about digital literacy. The data analysis technique used inferential analysis and quantitative descriptive analysis. This study uses two applications, namely electronic workbench in the experimental group and PhET simulation in the control group. The differences identified from the aspect of understanding concepts part of digital literacy and practical procedures. This research shows that the practicum process in a virtual laboratory using an electronic workbench N-gain a better conceptual understanding of literacy and laboratory skills related to practical procedures. In the process of implementing the practicum using an electronic workbench, experience is obtained in carrying out more thorough and accurate practicum procedures. In addition, this virtual practicum requires an adequate understanding of the concept of electronic components and the relationship between the measured electrical quantities.

INTRODUCTION

Problems in real practical learning, one of which is the condition that does not allow full learning to be carried out face-to-face. Therefore, virtual laboratories play a very important role as learning resources for students in physics education programs. Problems in electrical practicum require skills in assembling electrical circuits. The tools and materials available at home are not supportive and there are no measuring tools that can be used. Applications that can be used in virtual practicum are electronic workbench and PhET simulation. The use of this application strongly supports student scientific activities. Scientific activities and training in the laboratory are integrated into physics learning. Active learning through various learning methods, one of which is laboratory activities, is significantly effective in improving students' scientific abilities compared to traditional learning.

The relevant research results state that interest in mastering the material can also increase through laboratory activities that familiarize students with learning expert procedures to obtain data and skills (Halim, et al., 2018). The majority of educational institutions at the school and college level during the pandemic experienced a transition from the use of real laboratories for hands-on training with laboratory equipment to the use of virtual laboratories in online or digital form (de-Juan-Ripoll et al., 2018; Ruffinelli et al., 2020). This transition reduces the student's experience to directly practice and carry out laboratory activities.

Virtual laboratory technology is a representation of potential innovations that can transfer content knowledge and in-depth experiences to support science learning. The virtual practicum can explore and improve perception in a digital environment. Virtual practicum does not provide direct kinesthetic skills (Aeni et al., 2017; Azevedo, 2017). However, the user can control the visual senses in a way that approximates their reality function with sufficient accuracy (Billah & Widiyatmoko, 2018). The virtual practicum process provides an opportunity to observe how the visualization of various perspectives helps the development of students' cognition and complete knowledge (Chiu et al., 2016; Dusadee & Piriyasurawong, 2020). Students can explore and get data as well is similar to real life. The potential and benefits of virtual laboratories compared to real laboratories are certainly different from various aspects of the skills, knowledge, and experience (Nuryantini et al., 2021; Santoso & Munawanto, 2020). The advantages of virtual laboratories provide opportunities that are more practical, efficient, and economical. In addition, a hands-on experience feature can be added to provide guidance and brief information relevant to theory. The procedure for using a virtual hlaboratory is easier and can be repeated, clear visual and spatial representations are visualized although abstract skills and concepts are still found (Evangelou & Kotsis, 2019; Ferrell et al., 2019).

Interactive simulation capabilities and flexibility can be made more unique by presenting practical procedures. Various learning environments by using applications can increase students' motivation, critical thinking skills, abstract thinking skills easily expressed significant visual concepts for science experience. The ease of applying the application as a learning medium and being able to do repetitive exercises. Direct learning sourced from real experience can go through a faster and easier and more effective alternative process. The advantages of the virtual practice of electricity and its applications avoid the anxieties and worries that in real-life laboratory learning sometimes cause concern. The construction of conceptual understanding in the application of the application shows an increase in the learning experience that can be repeated if faced with errors so that the consequences of mistakes can be ignored. The virtual laboratory learning environment can be designed without many other factors influencing it so that the accuracy of the data can be trusted (Gunawan et al., 2013; Hung & Tsai, 2020; Husna et al., 2021). Immediate feedback and practice without restrictions and heavy risks can add to students' scientific conceptions and experiences of varied data collection.

This study explores the differences in project activities and digital literacy between students who receive electricity learning through the electronics workbench application and students who receive PhET simulation lessons. Virtual laboratory simulations are designed for more accurate data and reduce distracting factors like real laboratories. The application offers attractive visualizations and a wider variety of data collection procedures to support inquiry learning, problem-solving and project learning (Ermawati et al., 2018; Ismail, et al., 2020; Kapilan et al., 2021). Project-based learning connects the mastery of the material obtained by students in a class to be applied in the real world by making solutions to existing problems and playing a real role. Students' learning experiences are expected to be more meaningful in providing the skills needed to meet needs. A scientific approach to project performance trajectories will provide lifelong learning skills that provide benefits for surviving the skills-based competition (Susilawati et al., 2020).

The variety of projects applied at the technological level and their complexity are completed in a short time beginning with presenting problems for students to solve problems (Loveys & Riggs, 2019). In this research, the problem formulation is designed in project activities to obtain problem-solving. Projects that can be organized come from the ideas of teachers or students, but it is very important to be integrated with innovative learning media in the form of an electronics workbench application. Various applications that will be appointed as student projects have in common the two learning strategies consisting of a focus on open-ended questions, authentic learning, student-centered, integration of concept mastery and technology-based skills, independent learning skills, collaboration skills, analytical skills, reasoning skills, and complete project activities. Active participation in projects and critical thinking are expected to be optimally obtained by every student (Mutlu & Sesen, 2020). Independent activities can be carried out with the support of a variety of learning resources and a supportive environment in collecting data, tools, and materials for real practicum designs, internet connections, and regular assistance from teachers.

The novelty of this research is to compare project activities and digital literacy in virtual practicum between the electronic workbench and student digital literacy. The topic of electricity, the application of electronics workbench can be used optimally, this application requires mastery of concepts in both simple and complex electrical circuits. This application can be done repeatedly due to availability for download. In addition, there is a PhET simulation application that can be used visually to gain experience in learning electrical topics. This study investigates the comparison between learning using an electronic workbench application with PhET simulation on aspects of digital literacy, virtual practicum skills, data analysis and reporting as well as student interest.

METHODS

Participant

The sample of this study included two groups as 29 students in the experimental group and 31 students in the control group in the Physics Education Department, Faculty of Science and Technology, UIN Walisongo Semarang. The sample of this research was obtained through a purposive sampling technique that followed a practicum in a virtual laboratory. The experimental group implemented a virtual practicum through an electronic workbench. The control group implemented a virtual practicum through a PhET simulation.

Research Design and Procedure

The research method used in this study is a quasi-experimental design, namely pretest-posttest control group design (Creswell & Clark, 2007). This study compares project activities and digital literacy between virtual practicum assisted by the electronic workbench and virtual practicum with PhET simulation. The research procedure consists of the planning stage, implementation of practicum in a virtual laboratory, and assessment. The planning stage is carried out by studying literature, compiling virtual practicum guides and research instruments. The research instruments that were compiled were a test for understanding the concept part of digital literacy on electricity, an observation sheet on the results of project activities, and a digital literacy questionnaire. Furthermore, the research instrument was validated by an electrical material expert. The implementation phase of the virtual practicum was carried out three times, both groups were given different treatments, namely the experimental group using an electronic workbench application. In the control class using a virtual laboratory as it is done, namely PhET simulation. The initial step of the practicum is given a simulation of the use of a virtual laboratory, students are given time as a practice session, and ask questions about the use of virtual applications, tools, and materials. In the next step, students carry out project activities according to the guidelines given to complete two guided project assignments and two independent project assignments. After getting the practicum data, data analysis and report preparation were carried out systematically and thoroughly. Data collection techniques used multiple-choice tests of electrical concepts, project activity observation sheets, and questionnaires in the form of a Likert scale for student responses to digital literacy. The research procedure is briefly shown in Figure 1.

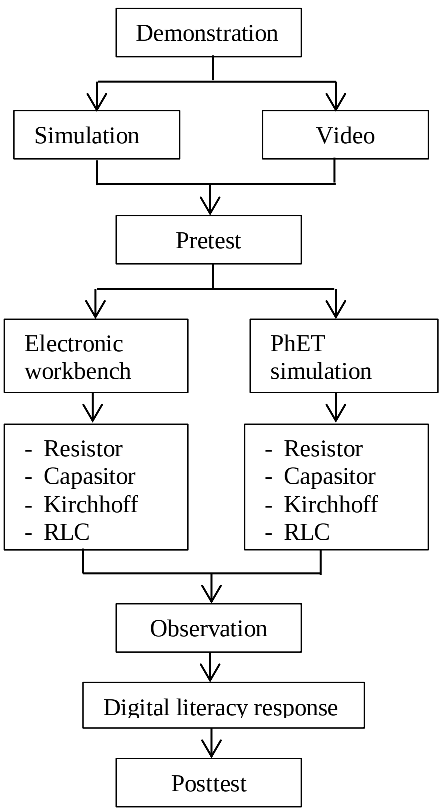


Figure 1. Research procedure

The data analysis technique used is descriptive analysis and inferential analysis. Quantitative descriptive analysis was used to show the mean, and standard deviation, for data on project activity observations, concept understanding test results, and assessment results for each project activity. Quantitative descriptive analysis for the percentage of student digital literacy. Inferential analysis to show effect size and t-test (Meyers, et al., 2013).

RESULTS AND DISCUSSION

The difference between pretest and posttest on the total score, initial ability, inference, and interest in the application with the comparison results at the significance level = 0.05. The pretest showed that there was no difference between the two groups before being given the previous electrical learning treatment. The difference in the mean scores between the pre-test and post-test in the two different treatments is shown in Table 1.

Table 1. The access skill applications in the experimental group who received learning through the electronic workbench application got a higher mean increase than the control group who received the PhET simulation application. The first aspect is to access the application, the experimental group on the pretest increases in the posttest has an average of 75.3 The control group on the pretest had a mean of 69.0 increased at the posttest had a mean of 75.1. The second aspect is to design electrical circuits, the experimental group in the pretest has an average of 86.3 increases in the posttest has an average of 87. The control group on the pretest had a mean of 76.9 increased at the posttest had a mean of 77.9. The third aspect is for understanding the components of electrical circuits, the experimental group in the pretest has an average of 79.8 increases in the posttest has an average of 88.0. The control group on the pretest had a mean of 74.8 increased at the posttest had a mean of 84.6. The fourth aspect for compiling project reports, the experimental group on the pretest has an average of 51.7 increases in the posttest has an average of 76.6. The control group on the pretest had a mean of 58.8 increased at the posttest which had a mean of 66.8. The fifth aspect is to present the measurement results, the experimental

group on the pretest has an average of 73.6 increases in the posttest has an average of 75.1. The control group on the pretest had a mean of 71.4 increase on the posttest a mean of 74.3. The difference in the average concept understanding score between the initial test and the final test on two different treatments between the electronic workbench and PhET simulation is shown in Table 2.

Table 1. Comparison of project activity assessment scores between the electronic workbench and PhET simulation

Aspect	***Pre***		***Post***		***Effect size***	***Diff***	***t***	***p***
	M	**SD**	**M**	**SD**				
1.Access the app								
Group 1: EWB	71.2	12.0	75.3	10.7	0.342	3.9	0.014	0.012
Group 2: PhET	69.0	12.1	75.1	12.2	0.417	4.1	0.012	0.000
2.Designing electrical circuits								
Group 1: EWB	86.3	15.1	87.3	14.8	0.291	4.0	0.015	0.067
Group 2: PhET	76.9	22.4	77.9	23.1	0.000	0.0	0.000	0.043
3.Understand the components of electrical circuits								
Group 1: EWB	79.8	17.9	88.0	14.5	0.461	8.1	0.024	0.034
Group 2: PhET	74.8	22.7	84.6	15.1	0.430	9.6	1.147	0.057
4.Compiling project reports								
Group 1: EWB	51.7	13.9	76.6	16.6	0.233	8.7	0.016	0.024
Group 2: PhET	58.8	12.0	66.8	16.0	0.567	8.6	2.115	0.055
5.Present measurement results								
Group 1: EWB	73.6	12.2	75.1	9.8	0.431	3.6	0.035	0.021
Group 2: PhET	71.4	12.5	74.3	11.5	0.326	4.0	2.231	0.000

Table 2. Comparison of concept understanding assessment scores

Indicator of Concept Understanding	*Pre*		*Post*		*Effect size*	*Diff*	*t*	*p*
	M	**SD**	**M**	**SD**				
1. Understanding of detailed								
Group 1: EWB	51.9	16.2	73.4	16.3	0.105	1.2	0.023	0.000
Group 2: PhET	54.7	13.3	60.9	11.5	0.524	2.7	0.471	0.012
2. Understanding changes								
Group 1: EWB	61.3	14.2	88.5	13.2	0.048	2.8	0.033	0.036
Group 2: PhET	62.1	12.8	75.6	15.2	0.215	3.1	0.061	0.071
3. Understanding predict								
Group 1: EWB	60.7	16.4	82.1	13.2	0.372	8.1	0.027	0.026
Group 2: PhET	43.9	20.5	70.3	11.6	0.424	7.6	1.136	0.048
4. Understanding of counting								
Group 1: EWB	65.6	12.2	72.7	15.4	0.210	8.7	0.015	0.019
Group 2: PhET	51.3	12.4	68.9	14.6	0.519	5.6	2.213	0.084
5. Understanding exemplifies								
Group 1: EWB	67.6	12.7	79.3	9.5	0.413	4.6	0.024	0.049
Group 2: PhET	53.4	12.6	77.4	10.2	0.362	5.3	2.246	0.000
6. Understanding describes								
Group 1: EWB	57.4	11.4	82.5	9.6	0.431	4.7	0.031	0.000
Group 2: PhET	62.4	10.3	83.3	10.7	0.338	4.3	2.265	0.000

Table 3. Comparison of inquiry virtual practicum scores

Aspect	*Resistor*		*Capasitor*		*Effect size*	*Diff*	*t*	*p*
	M	SD	M	SD				
1. Preliminary report								
Group 1: EWB	74.4	21.3	78.5	14.6	0.211	1.3	0.002	0.000
Group 2: PhET	55.5	32.4	67.8	13.7	0.432	2.9	0.005	0.032
2.Designing electrical circuits								
Group 1: EWB	85.1	23.1	89.6	15.3	-	2.1	0.132	0.000
Group 2: PhET	63.5	31.1	79.5	16.4	-	3.5	0.142	0.121
3.Measuring and reading measuring instruments								
Group 1: EWB	81.6	24.2	83.5	14.1	0	8.0	0.001	0.000
Group 2: PhET	56.7	32.3	71.2	12.7	0.431	7.2	1.278	0.076
4.Data collection								
Group 1: EWB	76.4	13.1	79.9	18.1	0.002	8.1	0.024	0.026
Group 2: PhET	61.5	11.5	69.5	16.3	0.531	5.3	2.154	0.168
5.Data analysis								
Group 1: EWB	69.8	11.5	80.6	17.7	0.050	4.1	0.031	0.022
Group 2: PhET	63.2	10.3	79.2	11.4	0.003	5.2	2.371	0.129

Table 4. Comparison of project virtual practicum assessment scores Group 1: experiment group; Group 2: control group

Aspect	*RLC Circuit*		*Kirchoff's Law*		*Effect size*	*Diff*	*t*	*p*
	M	SD	M	SD				
1. Preliminary report								
Group 1: EWB	75.1	12.1	79.9	11.4	0.312	8.2	1.322	0.013
Group 2: Phet	64.3	11.5	69.2	10.5	0.322	7.1	1.523	0.016
2.Designing electrical circuits								
Group 1: EWB	86.2	11.0	88.9	12.1	0.233	6.4	0.243	0.000
Group 2: Phet	64.7	13.1	78.6	11.6	0.256	6.6	0.351	0.221
3.Measuring and reading measuring instruments								
Group 1: EWB	83.7	9.2	87.4	13.8	0.000	6.8	0.112	0.000
Group 2: Phet	63.4	10.3	72.8	13.1	0.123	6.9	0.325	0.065
4.Data collection								
Group 1: EWB	72.1	12.5	78.8	12.3	0.000	7.6	0.015	0.014
Group 2: Phet	60.2	10.6	63.7	11.6	0.324	6.8	2.234	0.123
5.Data analysis								
Group 1: EWB	72.4	12.7	88.7	14.2	0.000	8.2	0.042	0.034
Group 2: Phet	65.1	11.4	76.3	10.6	0.022	6.4	2.216	0.128

Group 1: experiment group; Group 2: control group

Table 2. Concepts understanding measured in this study has 6 indicators, namely detailed understanding, understanding changes, understanding predict, understanding of counting, understanding exemplifies and understanding describe. Understanding of detail in the experimental group got an increase from the pretest with an average of 51.9 to an increase in the posttest with an average of 73.4; the control group got an increase from the pretest with an average of 54.7 to an increase in the posttest with an average of 60.9 Understanding changes in the experimental group increased from the pretest with an average of 61.3 to an increase in the posttest with an average of 88.5; the control group got an increase from the pretest with an average of 62.1 to an increase in the posttest with an average of 75.6 Understanding predict in the experimental group increased from the pretest with an average of 60.7 to an increase in the posttest with an average of 82.1; the control group got an increase from the pretest with an average of 43.9 to an increase in the posttest with an average of 70.3; Understanding of counting the

experimental group got an increase from the pretest with an average of 65.6 to an increase in the posttest with an average of 72.7; the control group got an increase from the pretest with an average of 51.3 to an increase in the posttest with an average of 68.9. Understanding exemplifies in the experimental group an increase from the pretest with an average of 67.6 to an increase in the posttest with an average of 79.3; the control group got an increase from the pretest with an average of 5343 to an increase in the posttest with an average of 77.4. Understanding describes the experimental group getting an increase from the pretest with an average of 57.4 to an increase in the posttest with an average of 82.5; the control group got an increase from the pretest with an average of 62.4 to an increase in the posttest with an average of 83.3. The difference in the average virtual inquiry practicum score between the initial test and the final test in two different treatments, namely electronic workbench, and PhET simulation, is shown in Table 3.

Table 3 implementation of inquiry virtual practicum on simple resistor circuit and capacitor simple circuit practicum. The assessment is carried out at the preliminary report stage, designing electrical circuits, measuring and reading measuring instruments, data collection, and data analysis. In the preliminary report stage, the average resistor circuit 74.4 and capacitor circuit average 78.5 in the experimental class experienced an increase in the score; the average resistor circuit 55.5 and the average capacitor circuit 67.8 in the control class experienced an increase in score. Observations at the phase of designing electrical circuits, the average of resistor circuit 85.1 and capacitor circuit average 89.6 in the experimental class experienced an increase in the score; the average of resistor circuit 63.5 and capacitor circuit average 79.5 in the control class experienced an increase in score. Observations at the stage of measuring and reading measuring instruments, the average of resistor circuit 81.6 and the average of capacitor circuit 83.5 in the experimental class experienced an increase in the score; the average of resistor circuit 56.7 and the average of capacitor circuit 71.2 in the control class experienced an increase in score. Observations at the data collection phase, the average of resistor circuit 76.4 and capacitor circuit average 79.9 in the experimental class experienced an increase in the score; the average of resistor circuit 61.5 and the average of capacitor circuit 69.5 in the control class experienced an increase in score. Observations at the data analysis phase, the average of resistor circuit 69.8 and capacitor circuit average 80.6 in the experimental class experienced an increase in the score; the average of resistor circuit 63.2 and the average of capacitor circuit 79.2 in the control class experienced an increase in score. The difference in the average virtual practicum project score between the initial and final tests on two different treatments as an electronic workbench and PhET simulation is shown in Table 4.

Table 4 implementation of project virtual practicum on RLC circuit and Kirchhoff's Law circuit practicum. In the preliminary report phase, the average RLC circuit 75.1 and the average Kirchhoff law circuit 79.9 in the experimental class experienced an increase in scores; the average RLC circuit 64.3 and the average Kirchhoff law circuit 69.2 in the control class experienced an increase in score. Observations at the phase of designing electrical circuits, the average RLC circuit was 86.2 and the Kirchhoff law circuit average was 88.9 in the experimental class, the score increased; the average RLC circuit 64.7 and the average Kirchhoff law circuit 78.6 in the control class experienced an increase in score. Observations at the stage of measuring and reading measuring instruments, the average RLC circuit was 83.7 and the Kirchhoff law circuit average was 87.4 in the experimental class, the score increased; the average RLC circuit 63.4 and the average Kirchhoff law circuit 72.8 in the control class experienced an increase in score. Observations at the data collection stage, the average RLC circuit 72.1 and the average Kirchhoff law circuit 78.8 in the experimental class experienced an increase in the score; the average RLC circuit 60.2 and the average Kirchhoff law circuit 63.7 in the control class experienced an increase in score. Observations at the data analysis phase, the average RLC circuit 72.4 and the average Kirchhoff law circuit 88.7 in the experimental class experienced an increase in the score; the average RLC circuit 65.1 and the average Kirchhoff law circuit 76.3 in the control class experienced an increase in score. Students' digital literacy is obtained from students' digital literacy responses in learning which is shown in Figure 2.

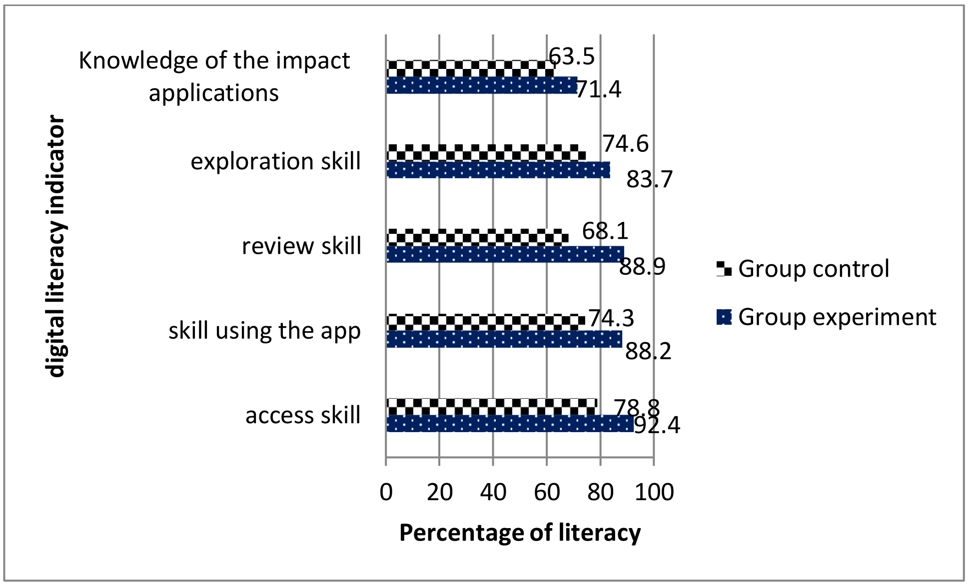
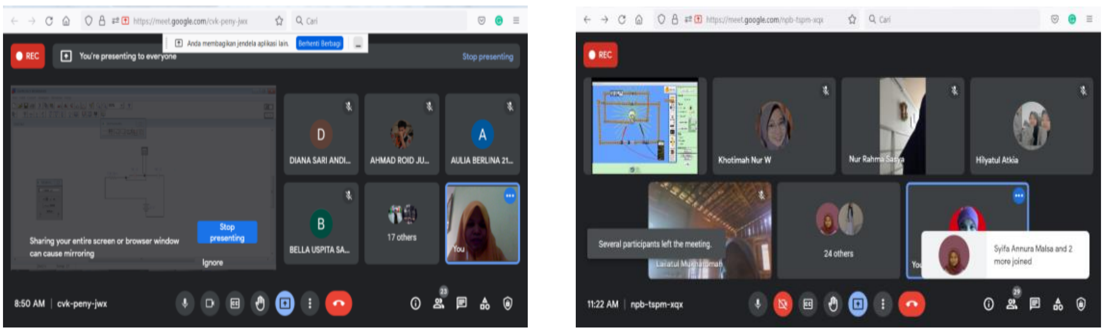


Figure 2. Student digital literacy responses



(a) (b)

Figure 3. Learning process (a) experiment group; (b) control group

Figure 2. Student digital literacy responses consist of 5 indicators skills to access applications, skills to use applications, skills to review knowledge and data, explore skills and knowledge on the impact of using applications. In the experimental group, student responses regarding digital literacy are in the very high category, while the control group is in the medium category (Bhatt & MacKenzie, 2019; Breakstone et al., 2018). Data access was 92.4% in the experimental group and 78.8% in the control group. The skill to use the application was 88.2% in the experimental group and 74.3% in the control group. Reviewing skills were 88.9% in the experimental class and 68.1% in the control class. Exploration skills were 83.7% in the

experimental group and 74.6% in the control group. Knowledge of the impact of using the application was 71.4% in the experimental group and 63.5% in the control group.

The project activities assigned to group 1 were comparable to those of group 2 because both groups were given the same assignment to design and complete the project. The difference in designing and completing projects is only in the use of application assistance between electronic simulation applications. Observation of project activities consists of the ability to access applications, design electrical circuits, understand electronic circuit components, compile project reports, and present measurement results (Hung & Tsai, 2020; Hirshfield & Koretsky 2021). The results of the study stated that the ability to design practicums can be carried out in virtual laboratories and live activities related to the digital literacy (Castilla et al., 2018; Lazonder et al., 2020). Electronic workbench application in project completion improves student learning experience towards accurate and virtual measurements that are close to reality (Halim et al., 2018; Evangelou & Kotsis, 2019). PhET simulation provides attractive visualization of images and is easier to apply to generate positive interest for students, but the measurement results have not yet generated measurement accuracy. These two virtual laboratories contribute to reducing cognitive load and have the potential as independent learning media in mastering content, increasing knowledge and learning experiences that include investigative activities.

In the assessment of students' conceptual understanding, there were differences between the experimental group and the control group. Time-limited learning and practice activities support students to increase their understanding of concepts. Learning activities with virtual laboratory media require activity, not just seeing, listening, and taking of traditional learning. Students who have a high learning category can achieve a high understanding of concepts. However, the limitation of using the electronic workbench application is that it is difficult to apply student collaboration skills to improve project performance results. The application also allows students to focus more on the thought process and leads to the ability to conclude. On the other hand, when a real project is carried out psychologically it diverts the student's focus from the content due to anxiety and failure.

Virtual lab technology is advancing rapidly, initially as a PhET simulation application that provides visualization of real practicums and abstract concepts. Furthermore, an electronic workbench application was developed that provides a measurement process and measurement results that are more accurate, thorough, and close to the real practicum process in the laboratory. Technical discussions can also be carried out by students independently with the results of project performance that are carried out independently and can be repeated (Childers & Jones 2017; Erol & Önder, 2021). Scientific performance using virtual laboratories, simulations are given information and habits to pay attention to work safety, especially on the topic of electricity, the magnitude of the voltage source, and attention to the safety of each electronic component. Thus, when scientific performance moves to a real laboratory, students are familiar with information and awareness in following work safety in a real laboratory (Billah & Widiyatmoko, 2018; Suyanto et al., 2021).

The advantages of electronic workbench provide simulations with scientific procedures, scientific processes, and scientific conceptions that lead to a deeper understanding of concepts in drawing conclusions. Demonstration activities, process observations, and experiments can be carried out on the electronic workbench in various ways. Four virtual practicum activities are carried out with procedures that are similar to reality. The practitioner prepares, designs procedures, collects data, assembles tools, measures, analyzes data, and reports. Effective exploration of learning content to build basic knowledge of electrical circuits can be provided by the application of electronic workbench starting from basic knowledge, inferential knowledge, and applied knowledge. Identification of student behavior and learning methods can be observed using this application because it shows students' pedagogical skills when presenting their work.

The virtual environment provides opportunities for students to discover new concepts and knowledge Fields (Nuryantini et al., 2021). Learning innovations can be built with modifications and developments in designing electrical circuits with various electronic components needed in accordance with the objectives of practicum activities. Cognitive ability, especially at the stage of analytical ability, shows the relationship between several physical quantities that can be obtained by students (Hu-Au & Okita, 2021). Science process skills in conducting practicum are still limited to the ability to observe, collect data, design, collect data, present, and fulfill report preparation. Learning facilitators can develop questions that become guidance and direction for students to carry out inquiry activities as well as project completion and problem-solving (Susilawati et al., 2020).

The use of an electronic workbench can increase students' digital literacy to be able to access data retrieval applications, skills to use applications, review skills, exploration skills, and knowledge of the impact of using applications. The use of an electronic workbench provides self-study and concept deepening because it is more accurate, thorough and guarantees work safety. Setting the use of applications that are very close to real practicum in the laboratory, not just visualization and not only showing abstract concepts to be more real (Luo, et al. 2020; Marchis et al., 2020). The availability of features, menus, and complete practicum tools fosters student creativity to explore further in designing variations of electrical circuits.

CONCLUSION AND SUGGESTION

This study compares scientific activities in project performance and digital literacy through a virtual laboratory in the form of the electronic workbench and PhET simulation. Both groups carried out practicum in a virtual laboratory. In the practicum through the electronic workbench, you will get experience in carrying out more thorough and accurate practicum procedures and provide an understanding of scientific content. Exploration and opportunities for understanding content and electrical practicum are obtained from learning through the application of electronic workbench in a more thorough, accurate, and complete manner. The learning context with both virtual laboratory applications can reduce the anxiety that often arises during real practicums.

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