Effectiveness of Virtual Physics Laboratory (VPL) with Dry Cell Microscopic Simulation (DCMS) to Promote of Inquiry Activity about the Battery

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Abstract. Electricity concept is a concept that is microscopic and difficult to see by eye directly (unobservable). A Unique example of the concept of electrical energy in the dry cell, cannot see the movement of protons and electrons so that the dry cell can produce energy. It causes the students have difficulty learning in finding the concept. The Virtual Laboratory with designed to increase the understanding of the concept of the workings of the dry cell to Promote of Inquiry Activity. This study was conducted to 202 teacher physics of senior high school in the experimental group by learning to use the Virtual Physics Laboratory (VPL) with Dry Cell Microscopic Simulation (DCMS). The results show the data from questionnaires for indicators of carrying capacity of the Laboratory of teacher the physics of and post-test is enough from the effectiveness of VPL with DCMS to Promote of Inquiry Activity about the Battery. The implications of using a virtual laboratory designed to overcome conceptual mastery difficulties can effectively assist students in facilitating promote of inquiry activity.

1. Introduction

The description of the learning achievement stated in the National Standard of Higher Education suggests that every university is required to be able to equip students with various competencies in order to compete with the challenges of the 21st century. These competencies include open thinking
skills, critical thinking skills, innovative thinking skills, problem solving skills, skills, collaborate, and communication skills, as well as ICT literacy that is collectively known as 21st century skills. In order for these competencies to be realized, there needs to be accelerated in an Inquiry activity [11] and problem solving activities (Problem Solving) [8]. Inquiry Laboratory is very important to be trained to students considering several considerations: (1) The effectiveness of higher education is being assessed in terms of the extent to which students obtain the skills they need to work in an inquiry-oriented laboratory [7]; (2) Universities throughout the world are expected to produce graduates who have skills in inquiry who are able to respond to changing and complex needs in the workplace [1]; (3) Selection of the world of work expects higher education institutions to instill inquiry skills into the curriculum [12]. In addition, inquiry also has a major contribution in building student competencies with a number of considerations: (1) if able to develop problem solving skills, one can take decisions objectively and independently [13]; (2) Through problem solving, the ability to think of students becomes more skilled in selecting relevant information then analyzing it and finally re-examining the results; (3) Fostering the development of feelings of attitude (wanting to know more) and critical-analysis both individually and in groups.

The laboratory is an effective form of learning to develop student understanding and scientific process skills [7]. There are at least four reasons for the importance of laboratory activities: (1) Laboratories can generate motivation for learning science; (2) The laboratory can develop basic skills in experimentation; (3) Laboratories as a tool for learning how to apply scientific approaches; 4) Can support the mastery of laboratory learning material. The main purpose of the physics laboratory is to improve physics knowledge; develop practical skills; creating interest, developing creative thinking and problem solving skills; develop scientific thinking skills and training with experimental methods [13]. Laboratory activities are also the best way to reflect the nature of science [5] [6] and be rich in context, develop conceptual understanding, develop practical skills [2]. The concept of electricity is microscopic and difficult to see directly by the eye (unobservable). A unique example of the concept of electrical energy in the dry cell, cannot see the movement of protons and electrons so that the dry cell can produce energy. The battery is a device that can store chemical energy and make electricity when needed. It is widely known for its use as an energy source for electronic goods such as batteries, toys, lanterns and others. The perfect battery is easy to carry as a source of electrical energy. The potential difference between the two parts of the electrode is electricity produced by batteries that come from electrical energy. The difference in potential is known as cell potential or electromotive force. To complete the reaction in the battery, charge transfer media and external circuits are needed as an electric current.

However, looking at batteries, which require the environment to be able to see the movement of an electric current, it is necessary to have a computer simulation designed to better understand the working concept of dry cells. Small conceptual changes can be made with microscopic particle size, direct experience. Then simulation is needed as a tool to visualize microscopic concepts through virtual simulations. The virtual multimedia development phase of this study includes the analysis, planning or design, production and evaluation phase [3].

A software application that can be used to create virtual simulations is Macromedia Flash 8.0 and Java. Some of the advantages of this simulation can combine text, animation, sound and color. Based on the description mentioned above, the formulation of the problem is the Virtual Lab which is designed to provide a better understanding of the concept of work activities of dry cells microscopic simulation (DCMS) Promote of Inquiry Activity.

2. Virtual Physics Laboratory

Modern service systems are complex, distributed multi-factor systems. Simulations have gained popularity for teaching and analyzing how various parties’ interactions, decisions and collaborations are managed when designing and using complex systems and for learning approaches [4] [6].
Some teaching materials related to virtual media have been developed in the PhET Simulation at the University of Colorado in a form that is accessible in part to the public for free and can be downloaded by physics. The battery concept is a very complex and related concept of microscopic rotational dynamics. One method that teachers can use to make it easier for students to understand concepts in battery material is a practical method. Laboratory activities can make students able to solve problems according to the physical theories learned in class [1]. Revealing the problem above shows that a learning design that suits your needs is needed. Basically, multimedia for learning with information technology can help develop learning independence and conceptual understanding. This is a combination of various audiovisual environments that can be used in multimedia learning, teaching and learning activities [4]. The way the teacher can mediate interactions with students is virtual learning. The virtual form of mediating teacher-student interactions is a simulated environment. Therefore, in this research, multimedia learning is designed with the concept of a virtual laboratory through technology-based simulations. Microscopic and macroscopic phenomena can be defined at certain scales by simulation, so that they can be clearly observed by students.

The simulation applies to the topic of rotational dynamics, which includes: macroscopic device while the wheel rotates in an inclined plane. In order for students to see the concept of rolling, it must be facilitated by the wheel in rolling motion and what causes the wheel to spin. The virtual simulation laboratory can be used as a tool to understand the concept of rotational dynamics. The teacher can practice the independence of student learning through a flexible learning environment in terms of time and space, so students want to review learning later. Basically, multimedia with an Android smartphone can be adjusted to operate the function of flexibility in space and time according to student needs. Using basic learning with a mobile device (also called m-Learning) contributes positively to students' access to learning material and opportunities to learn independently.

3. Inquiry Activity

In recent years, research has announced that students are moving towards science classes with academic concepts and ideas about phenomena and concepts that are incompatible between their views of knowledge. In addition, concepts and ideas are held firm and resistant to change [11]. Improving the quality of the physical learning process and student learning outcomes requires serious efforts, one of which is implementing a research education model. This includes the inquiry-based learning process, the procurement problems, and the acquisition of information. Think creatively about possible problem solving, decision making and conclusions. This model focuses on the ability of students to observe, collect data, understand information, make concepts, use verbal and nonverbal symbols, and solve problems related to physics. However, teaching by analogy is an effective teaching method in preventing the high learning success and misunderstanding [14]. Conceptual change strategies are designed according to students' alternative understanding. Students 'understanding of consistency in this study includes the pattern of students' answers using the same concept model while answering a series of questions that ask the same concept. This data was obtained with a hand consistency test that was tested by asking questions more than once with the same concept.

In the last thirty years, the term science education has been used as a synonym for learning 'good and meaningful' science in science education. The statement that students must study science by imitating the process of creating knowledge in science is not new and has been a major idea in the reform of science education since the 1950s. Research learning in science education defines the approach that students actively learn using scientific methods to answer research questions [11]. This definition requires two minimum requirements to qualify an activity as inquiry learning: (a) students answer research questions (b) by applying scientific methods. Therefore, activities such as making atomic models or drawing wildflowers are not learning activities because students do not answer research questions. Gathering information in the library or on the Internet to learn how to produce liquid oxygen is through research because students do not apply the scientific method, even if they answer questions. Analysis of what is considered 'research, learning' does not mean that these activities are not important, it just means that they are not sufficient to meet the strict definition of
research learning [14]. However, the entire learning, research cycle for asking research questions, collecting data, and interpreting results is not always used in science classes. Activities in proxies change. In some cases, teachers provide research questions, data collection methods, and comments; in other cases, the teacher leaves students responsible for some or all of their research learning. Determine four levels of research, learning based on the amount of guidance from the teacher see Table 1 [14].

In invalidation (level 0), the teacher provides guidance on how to interpret data to answer research questions, data collection methods, and research questions. Level 0 activities are traditional 'book-like' activities that provide direction to answer research questions. In structured inquiry learning (level 1), students are given research questions and data collection methods, but no guidance is given on how to interpret data. In guided inquiry learning (level 2) students are given research questions, but no further guidance is given. In open inquiry learning (level 3), students choose data collection methods and interpret data to answer their own research questions without any guidance. This rubric captures the various levels of complexity of research learning in classroom settings and the number of guidelines provided. Therefore, younger and less experienced students need to work in lower-level activities, while students with more experience need to work on more complex learning activities to practice and develop science process skills. Researchers can also use this rubric to interpret evidence about the effects of inquiry learning, because it provides criteria for systematically comparing the various teaching and learning activities used in the classroom or laboratory.

4. Method

4.1. Research Design

The aim of this research is the Effectiveness of Microscopic Simulation of Dry Cells (DCMS) and Virtual Physics Laboratory (VPL) to Increase the Effectiveness of Battery-Related Demand. The quantitative research design used is the design of one group pre-test, post-test [9]. Understanding the concept of experimental group that is applied only using a group of poster designs as shown in Figure 1.

![Figure 1. One Group Posttest Only Design](image)

Information:
- O: The test conceptual understanding of physics of microscopic phenomena
- X: Treatment of Virtual Physics Laboratory with DCMS for inquiry activity on experimental group.

4.2. Study Participants

The respondents were 202 high school physics teachers. Samples were selected from second grade teachers who gave random introductory physics lessons. Some of these students study VPL at a high school physics laboratory in Banten Province, Indonesia.

5. Analysis

5.1. Development Dry Cell Microscopic Simulation (DCMS)

The virtual multimedia development phase in this research includes the analysis, planning or design, production and evaluation phases [15]. Successfully analyzing the thermal expansion of solid materials by considering the material involves several abstract concepts, so it is very sensitive when interactive multimedia is created, which can simulate events that are difficult for students to observe and simulate dry cells (batteries). As a result, it has been proven that the use of virtual media can
change the students' understanding with conceptual understanding through deep conceptual reconstruction [4].

Figure 2. Result of Development DCMS

Figure 3. Reaction of zing electrode and carbon electrode for DCMS

5.2. Data need Assessment VPL

Data from the need assessment results in the form and feasibility of laboratory in high schools were obtained from the results of distributing questionnaires directly to high school physics teachers in West Java. The questionnaire is also distributed online with the url address https://goo.gl/forms/D9gA2yJAgJsjesbA2. The number of respondents from the results of the questionnaire was 202 people. The indicators contained in the questionnaire are seven, namely: 1) Laboratory Carrying Capacity, 2) Laboratory Implementation. The categories for each indicator are converted in the form of percentages consisting of: Less (0% - 33.3%), enough (33.4% - 66.7%), Good (66.8% - 100%).

The results of the questionnaire distribution for each indicator are presented as follows. 1) Carrying Capacity of Laboratory Data from questionnaires for indicators of carrying capacity of laboratory are shown in Table 1. The power to support the laboratory in each school is considered sufficient.
Table 1. Practical Capability

| No | Questionnaire items                                         | TotalIdeal | Total* | % | % Total** | Category |
|----|-------------------------------------------------------------|------------|--------|---|-----------|----------|
| 1  | My school has a physics laboratory room                     | 204        | 156    | 76.5 |          |          |
| 4  | Laboratory activities are guided by a laboratory book / module | 204        | 175    | 85.8 |          |          |
| 5  | The physics laboratory at my school is supported by a laboratory | 204        | 64     | 31.4 |          |          |
| 8  | The laboratory equipment that is owned is in accordance with standard requirements | 204        | 87     | 42.6 |          |          |
| 16 | I have good knowledge and mastery of laboratory models       | 204        | 83     | 40.7 |          |          |
|    | **Total**                                                  | **1020**   | **565**|    |           |          |

Note: * The number of respondents who answered "YES"  
**% total = (Number of respondents who answered "YES" / Ideal Number) x 100%  
= (565/1020) x 100% = 55.4%.

Based on table 1. The information data from questionnaires for indicators of carrying capacity of practicum in sufficient categories. However, that the development of VPL is needed to support the achievement of learning that becomes the demands of 21 Century, namely literacy for learning with inquiry especially Battery.

5.2.1. Implementation of Laboratory

Data from questionnaires for indicators of laboratory implementation are shown in Table 2. The laboratory implementation in each school is considered sufficient. Additional information related to indicators of laboratory implementation was obtained information that teachers who stated that they did not do laboratory = 2 people (2.0%), practiced 1-4 times per semester = 170 people (83.3%) and practiced 5-8 times per semester = 30 people (14.7%).

Table 2. Practical Practices

| No | Questionnaire items                                         | TotalIdeal | Total* | % | % Total** | Category |
|----|-------------------------------------------------------------|------------|--------|---|-----------|----------|
| 2  | I held a laboratory / experiment to support learning         | 204        | 196    | 96.1 |          |          |
| 3  | Every important concept or main concept that I teach is supported by practical activities | 204        | 25     | 12.3 |          |          |
| 6  | I conducted a separate laboratory with theoretical learning  | 204        | 117    | 57.4 |          |          |
| 7  | I carry out laboratory integrated with theory learning       | 204        | 160    | 78.4 |          |          |
|    | **Total**                                                  | **816**    | **498**|    |           |          |

Data from questionnaire distribution for laboratory barriers indicators are shown in Table 2. Practical barriers faced by teachers in each school are greatest in terms of practical time limitations and the smallest obstacles in terms of student motivation to conduct low laboratory.
Based on the data, information has been obtained in which students build a logical and consistent understanding of phenomena and concepts, as seen in their own interpretations, which are incompatible with views universally accepted by the Science community [14]. Media simulations help students build their understanding to improve their understanding [34]. The use of virtual simulation environments on concepts enhances understanding of process concepts for scientific concepts of student inquiry activities. Learning physics simulations using electric magnetic media can transform non-scientific student understanding into scientific understanding.

6. Conclusion
This study the implications of using a VPL designed to overcome conceptual mastery difficulties can effectively assist students in facilitating promote of inquiry activity. The results suggested that incorporation of learning by DCMS for inquiry activity with VPL. The information data from questionnaires for indicators of carrying capacity of practicum in sufficient categories. However, that the development of VPL is needed to support the achievement of learning that becomes the demands of 21 Century, namely literacy for learning with inquiry especially Battery. Based on the results of the study and discussion of the results of this study, the results presented here show that students who work with virtual simulations show significantly higher scores. Our findings strongly support that DCMS can be used as an alternative teaching tool to enable students to understand physics concepts.

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