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by Sondang R. Manurung

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Improved Problem-Solving Ability after using Interactive Multimedia in Teaching of Ideal Gas

Sondang R. Manurung* and Satria Mihardi

Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan, Medan, Indonesia; sondangmanurung@unimed.ac.id,mihardi@unimed.ac.id

Abstract

Objectives: To investigate the effect of interactive multimedia in gas ideal teaching on problem-solving ability performance of prospective teacher. **Methods/Statistical Analysis**: The method used is quasi experiment with pretest-posttest control design. A test of problem solving ability consisting of six essay questions. Sample were selected by random method (probability sampling). The experimental groups of 40 students was taught by interactive multimedia in gas ideal teaching while the control group of 40 students was taught by traditional method. Hypothesis testing is used by the t-tes. **Finding:** The finding of this study was the experimental classes that are taught with interactive multi-media in gas ideal learning get an average score of problem solving abilities is 80.50 and the control class taught with conventional learning obtains problem solving abilities with an average of 74.96. The data above showed that t count> t table (3,514> 1,667), that the problem-solving ability of students who learned physics using interactive multi-mediabased problem solving was better than of students who learned through conventional methods. In addition, in ideal gas learning based on interactive multi-media students conduct problem solving and physical symptom exercises shown by multi-media, so that they understand physics thoroughly and are skilled at performing problem-solving tasks. Multi-media helped them emphasize and engage actively in problem-solving process as it is related to real materials and real life situations which made it easier for them to remember. **Application/Improvements:** To improve this media, the involvement of students in problem-solving task and multi-media helps retention of students' knowledge and motivates interest can be applied to other physical materials.

Keywords: Ability, Ideal Gas, Improved, Interactive Multimedia, Problem-Solving, Teaching

1. Introduction

Physics lecturer candidates are expected to have professional competence and high problem-solving abilities[1]. However, this would be a far-fetched dream if those who teach them do not give them adequate stimuli and materials that would make them outstanding educators. Efforts to increase the competence of lecturers at the Lembaga Pendidikan Tenaga Kependidikan (LPTK) Medan, have not produced satisfactory results. A preliminary study on the learning of General Physics in LPTK Medan,which was conducted by[2], showed that in general, lecturers still dominate the learning/teaching process. In this case, the transfer of knowledge was done using a one-way teaching method[3,4].

In general, lecturers use the question-and-answer method when teaching. In addition, the implementation of General Physics practicum are still largely based on a method of verification where each step is carried out precisely, as if following a recipe, in order to prove existing theories. This method does not encourage students to develop their thinking and find new ideas during lab experiments[5]. It was also found that: 1. A one-way lecture strategy used in teaching General Physics class failed to inspire students to do anything other than listen or get bored. This is because learning situations wereaimed at only learning to know and the problem set tended to be academic (book-oriented); 2. Students lacked the experience to solve problems and the problems given were not contextually relateable to their everyday life, thus the

*Author for correspondence

process became less meaningful to them. This was evident from the low participation of students in discussions during the teaching and learning process. Their achievements were also unsatisfactory. Subsequently, several weaknesses in the process of teaching/learning General Physics were found: 1. The learning process failed to enlive the physics concept/phenomenon to students, 2. A lack of discovery process and 3. A lack of instructional media, which tends to be nonexistent. These weaknesses cause difficulties for students to understand the concepts of General Physics, including graphs which are often featured in physics material. Thus, the low quality of teaching, in terms of students' results and participation in the learning process, was due to non-optimal teaching by the lecturers[6].

To increase ability of students, it is thus necessary to improve the professionalism of lecturers through continuously perfecting education for lecturer candidates. This is because lecturers hold the key to improving the quality of teaching and the learning process[7,8]. One requirement of the learning process is for teachers to provide students with the knowledge and direct experiences that will stimulate their thinking[9]. Thus, students should not be limited to only learn in class or lab but should also be given the chance to do experiments that involve abstract physics concepts using relevant interactive multi-media[10,11]. Learning to do experiments outside the laboratory can provide opportunities for students to reflect on their thoughts, emotions and actions as well as help change their behavior and enable their minds to thrive[12].

Currently, lecturer candidates are not prepared for real class situations; there is a gap between what they are exposed to compared to what they encounter after becoming lecturers. They are usually given problems in general physics in the form of certain information (usually numerical value for certain variables) which is provided in order to determine the value of other variables[13,14]. In such cases, problems tend to be well-defined; however, problems faced in everyday life are not always that well-structured. Thus, students should be provided with innovative ways to learn physics[15,16], which can sharpen their critical thinking and problem-solving abilities. Educators need to equip students so that they can apply their knowledge, skills and understanding in different situations in order to solve problems[17]. To eliminate this gap, Jonassen (1997) suggests that using multi-media for learning can encourage students to experience the discovery-learning process and learn to solve problems that are poorly structured[18,19]. In[20] also state that giving students a web-based problem-solving model as an additional way of teaching will not impair their understanding. Thus, providing knowledge via simulation and virtual labs to teach a variety of basic physics concepts based on algebra through PhET (Physics Education Technology) would free students from the usual routine of monotonous and uninspired lectures and labwork. In the final analysis, using multimedia can help stimulate students' minds as well as give them a better chance to become qualified educators in the future.

Interactive multi-media (virtual labs)[21] can be defined as a series computer programs that can visualize abstract phenomenaor complicated experiments carried on real laboratory, so as to increase learning activity in an effort to develop that skill needed in trouble shooting. For example, it is very important to give a real example in the daily life of the benefits of ideal gas. This approach makes the class interesting for students. If the class is interesting, they will be more happy and more likely to absorb lessons. In this activity, the students conduct their own lab with the help of student worksheet. The results of the experiment is analysed then discussed in class and concluded. This makes learning interesting and not boring.

This study aimed to evaluate how using interactive multimedia help lectures improve students' problem-solving abilities. It is hoped that this method can aid students in understanding the teaching materials as well as finding solutionsfor many poorly structured problems.

2. Method

The method used was a quasi-experimental method[22] to test the model in a limited classroom setting. Pre-test and post-test control groups were designated. The study involved two classes that were each given a different treatment. The first class/group learned through interactive multi-media (MMI-PS), while the control group was given conventional teaching/learning methods. Each group consisted of 40 second semester physics students at LPTK Medan. A test consisting of six essay questions was used as the research instrument in order to assess the students' problem-solving abilities. The questions cover problems about the characteristics of ideal gas, the laws of ideal gas and the application of ideal gas state equation. The test's reliability had been validated prior to the research. After the pre-test, the two classes received different teaching methods. In the control class, a researcher taught the lesson using conventional method where educators provide

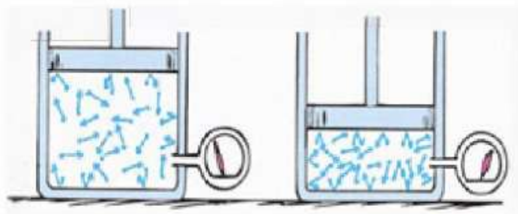

Figure 1. When the volume of gas is decreased, density and therefore pressure are increased.

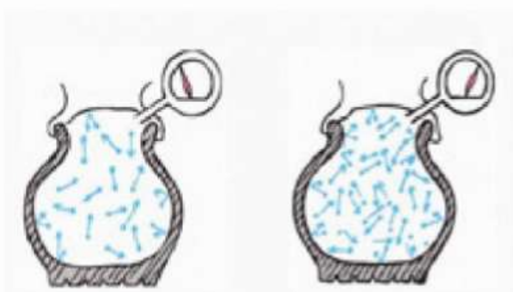

Figure 2. When the density of gas in the tire is increased, pressure is increased.

learning through lectures. Meanwhile in the experimental class, educators taught using a multimedia-based learning model. Here, educators used computer media to make students more active in analyzing a problem. Learning materials were 1. Understanding and characteristics of ideal gas, 2. Laws on ideal gas and 3. Application of the ideal gas equality equation. Understanding and Ideal Gas Characteristics, shown below Ideal gas animation Figures 1 and 2.

Then examples of problem solving were given, then the lecturers and students solved it. After the two groups finished their different treatments, they were given a post-test to compare the results of the two teaching methods. Experimental method with pretest-posttest control group were used. Research design are shown as follow (Figure 3).

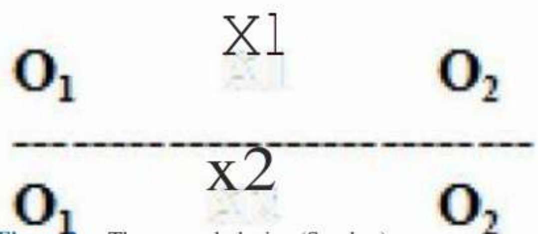

Figure 3. The research design (Sumber).

Information :

O1 = Pretest given to the experimental class and control class before treatment

O2 = Postest are given after the treatment in the experimental class and control class

X1 = Teaching by applying interactive multi-media based instructional model with problem solving I (MMI-PS) problem on ideal gas material.

X2 = Teaching by applying conventional teaching on ideal gas material

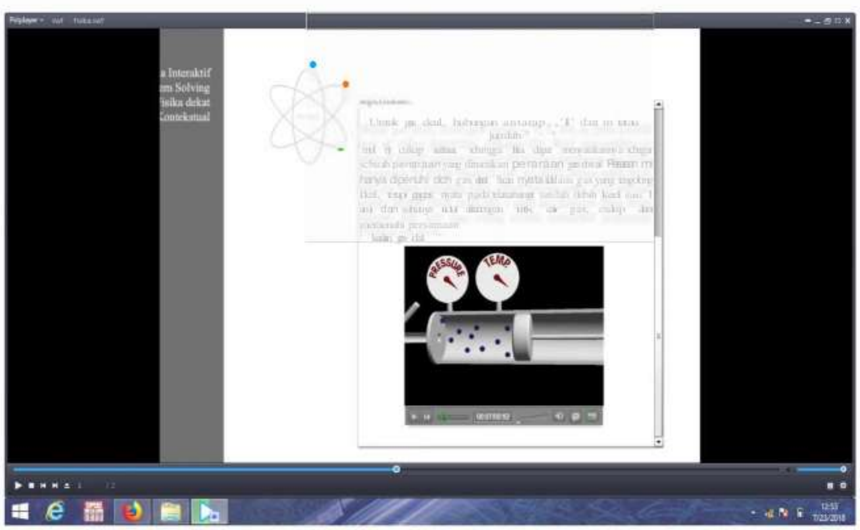

Figure 4. Simulation of how molecules in a gaseous state behave in an enclosed space.

Analysis of need was conducted as a preliminary study to determine the most fundamental thing needed in class in relation to the use of multimedia based learning program. Lecturer used multimedia to help students understand basic concepts about the problems given. Then, lecturer directed students to deduce solutions based on the simulation conducted using multimedia (MMI-PS). The normality of data were tested using Kolmogorov-Smirnov and Shapiro-Wilk statistics and homogeneity variants between groups was tested using Levene's Test

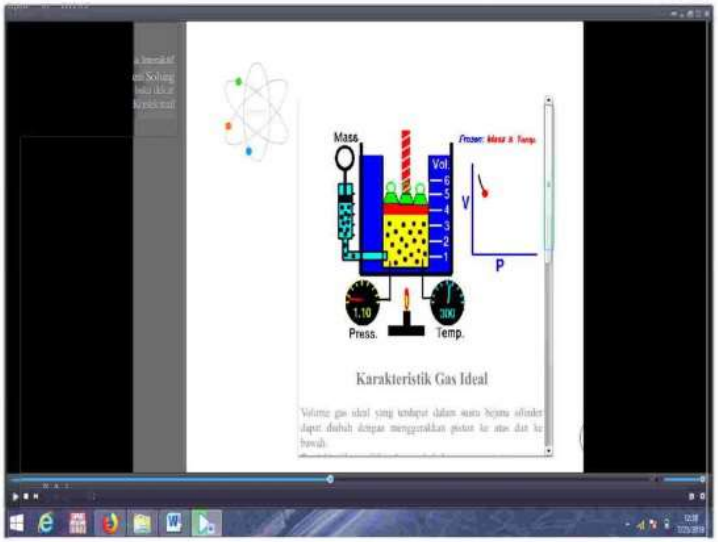

Figure 5. Visualization of ideal gas characteristics.

Figure 6. Features of MMI-PS.

and Box's Test. In order to test the differences in students' problem solving ability, t-test analysis were used.

The page showing the procedures for carrying out the experiments in the virtual laboratory system is shown in Figures1-2, while the program compilation page of the simulation environment is shown in Figures 4 and 5. The set-up for the implementation and demonstration of the proposed virtual laboratory software to perform ideal gas experiment in physics is also shown in Figures 4-5. Interactive multimedia learning can initially be done by clicking on the features shown in Figure 6.

3. Findings and Disscussion

This multimedia-based learning model is a means to understand important aspects of the material presented, mentally organizing it into a coherent, cognitive structure and integrating it into existing relevant knowledge. Through multimedia-based learning, we can also meaningfully implement a model of what happens in new situations and measure learning outcomes by using a problem-solving based test. A multimedia-based learning model can help develop student progress. With this type of learning, students learn higher-level thinking skills since it takes into account the needs of learners in order to develop their cognitive abilities[20]. With this method, students might be more eager to highlight their ideas, which is part of the process of solving problems through observation, analysis, planning and evaluation[23]. This, in turn, is expected to result in better student performance.

Based on the pretest (initial ability test) result, the lowest, highest and average score of the experimental class are 52, 78, and 68.3 respectively. Meanwhile, in the control class, the lowest score was 45, the highest 76 and the average 65. The homogeneity test revealed that the variance of the two groups were homogeneus ($p>0.05$), meaning that both class have the same initial ability.

Based on the post-test, the scores obtained by the experimental class ranged from 66 to 92, anaverage of 80.50 and a standard deviation of 5.38. At the same time, the control class obtained scores ranging from 61 to 90 with an average of 74.96 and a standard deviation of 7.61. Data of the experimental class post-test and control class can also be shown through bar charts such as Figure 7.

This indicates that the experimental class had better performances. From the result of t test, it was found that the difference of post-test results between the two groups was significant ($p<0.05$). This implies that there is a significant increase in the problem solving ability of the experimental group. This research shows that multimedia-based learning is more effective than a conventional one. This result is in accordance with[6,21,22], which states that

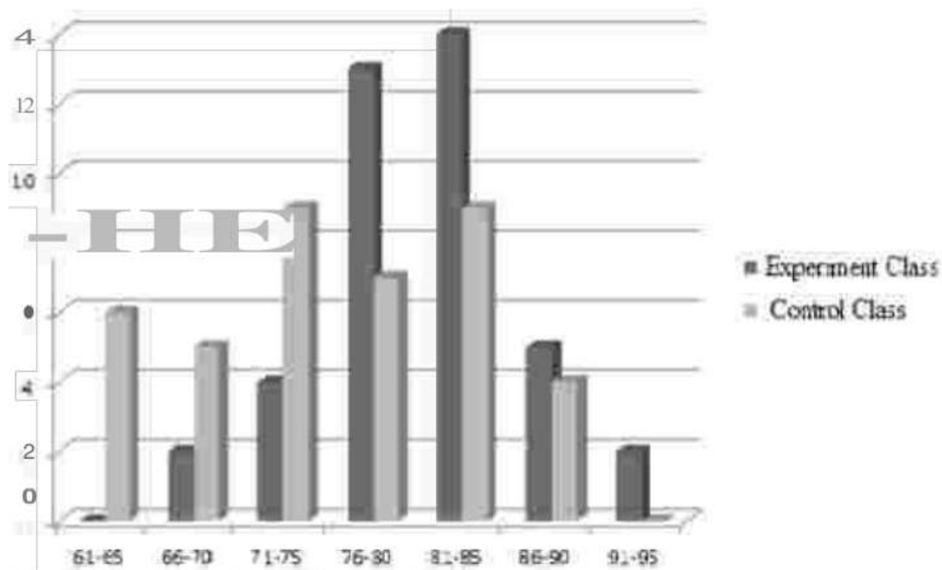

Figure 7. Diagram of experimental class and control class post-test data.

student scores after using Problem-based Learning (PBL) levelled up into the medium category; they achieved very good/high to average scores and their learning outcomes improved. This is also in line with research conducted by[24], who stated that problem-solving learning model provides positive effects in physics, especially in the competence dimension of knowledge. The increase in problem solving skills after being taught through interactive multi-media-assisted problem solving is also in line with[24] who state that the percentage of students who did not understood the lesson dropped from 60% to 5%.

Learning through interactive multimedia is deemed capable of providing learning experiences on par with the development of students' cognitive abilities[25]. This is because interactive multimedia gives students the chance to observe physics phenomenon using a virtual laboratory which will help them tremendously in understanding the materials being taught so that they can solve the problems involved[26]. By using interactive multimedia, students were able to derive knowledge and answer about a particular problem by observing and doing simulation directly. In addition, multimedia helped them emphasize and engage actively in problem-solving process as it is related to real materials and real life situations which made it easier for them to remember.

The positive outcome of using interactive multimedia is also linked tightly to the role of lecturers. They are the instructors who guide and direct students in this process. They repeatedly provide assistance when students are at lost. This will in turn keep students motivated so that they are more willing to invest their time and energy to focus on the materials given. In[27] states that problem-based learning is a learning approach where students construct knowledge by working independently on authentic problems, while the teacher acts as a facilitator. Thus, rather than passively receiving material from lecturers, interactive multimedia encouraged students to actively think and learn while still being guided[28]. This way, students will unwittingly develop independence and confidence so that better learning outcomes are achieved. Based on our observation during class, students were very enthusiastic when they are provided with interactive multimedia. One of the reason is because this mode of teaching/learning has rarely been given to them. This shows the importance of teachers' creativity to provide students with non monotonous mode of teaching to keep them engaged and their interest sparked[29].

4. Conclusion

The use of aninteractive multimedia learning model is effective in improving student problem-solving skills. Learners are more active and engaged and thus, they achieve more effective learning. In addition, multimedia-based learning allows learners to build knowledge in solving problems while going through the stages of planning, comprehension, application, analysis, evaluation and problem-solving. This positive result could not be separated from the irreplaceable role of lecturers. They hold the crucial position like that of a mentor who guide and motivate students throughout class. In addition, with the help of interactive multimedia, lecturers are able to provide information/teaching material in a more focused and systematic way, hence learning goal is easier to achieve.

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