The effectiveness of science experiment through multimedia teaching materials to improve students’ critical thinking

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Abstract. The aims of this study is to explore the effects of three different forms multimedia teaching to critical thinking skills of students in the context of the science laboratory. The three forms of multimedia teaching materials are static images, videos, and animations, that used to teach science trial for 120 students from Elementary School teacher education university of Samudra, Langsa. The method used in this study is a quasi-experiment with pretest to posttest control group design. The pretest method was given to college students to determine their learning achievement before given the application multimedia to experiment science during learning process for the experimental group and also the implementation multimedia and learning feedback from a list of several questions. Descriptive statistics and ANOVA were also given to analyze data that have been collected. This study shows that videos and animations have bigger effects in critical thinking skills in the context of science laboratories rather than static images and observation performance. In addition, animation video in presentation can help students to understand the experiment and learning science easily.

1. Introduction
Science learning fundamentally involves students directly in obtaining their knowledge so curiosity arises. To explore the curiosity of students, one effective way to do is by applying experiments in learning activities. Experiments are not only able to increase a sense of curiosity of students, but also able to increase the ways of students to think rationally and scientifically so the results of the experiments can accepted as a scientific product while steps in its implementation as a scientific process.

Science learning basically is a collection of knowledge, about ways of thinking and investigating. So, in studying natural materials students are required to use all skills they have, such as thinking and working skills [1-3]. Science education has an important role in preparing children enter real life. Learning science is essentially a product and process. Therefore, the concept of learning science is formulated systematically, mainly based on observation and experiments [4].

Although multimedia teaching methods and other techniques have been applied, it still does not reveal student learning abilities. Multimedia applications that are fun and interactive in teaching science can change the concept of student understanding, especially multiple student representations of science concepts. Learning that is implemented optimally can increase creativity and motivation in learning activities, especially in terms of the quality of education [5-8].
Fortunately at the same time, this learning concept make it easier for teachers to teaching in the class so that the learning atmosphere takes place smoothly and efficiently. In addition, for cognitive students, the use of multimedia in science learning can increase interest, enthusiastic students in learning about the science experiment. Integrating molecular forms, text, sound and also moving images, can explain various science phenomena, presenting chemistry laws more clearly, so the quality of learning and student interest can be improved [9-11].

The application of multimedia technology can provide a clear and more realistic scientific concept in the classroom, so students can understand the phenomenon of images according to what they understood at that time. as we know that teaching traditionally illustrates such scientific concepts, so students find it difficult to understand. Effective use of multimedia applications can reduce the amount of writing and drawing that can confuse students on the board. The teachers can explain the concept of science even more in the class. In addition, the information provided by the teacher is clearer than just traditional teaching. Therefore, it is necessary to use multimedia teaching materials in science learning so that the quality of learning becomes better.

The scientific phenomena that are displayed in multimedia learning when the experiment activities take place must be related to the concepts learned by students. For example giving molecular phenomena to elements and acid bases that are directly related to chemical concepts in everyday life. The use of context models as a direct application of concepts makes it easy for students to understand the concepts being learned [12]. However, most teachers still lack multimedia in science experiments, especially showing real demonstration experiments in the classroom. learning concepts like this must be applied. Experimental activities that are applied multimedia will train students to observe and analyze the science process. besides this learning activity is also expected to be able to guide students to understand the concepts of real science [13]. As can be seen in the relevant research, laboratory activities play an important role in the progress of science education. Even the laboratory in teaching science has a significant effect in improving student learning outcomes [14]. In this case, the aim of this research is to investigate the effectiveness of science experiments through multimedia teaching materials for students.

2. Methods
This research was conducted in science trial for 120 students of Elementary School Teacher Education, university of Samudra, Langsa From September 2018 to January 2019. The type of research that use is Pretest to posttest control group design [15-16] as shown in the following Table 1.

Table 1 Design Research

| Class       | Design | Treatment   | Test | Begin | End |
|-------------|--------|-------------|------|-------|-----|
| Experiment  | O₂X₁O₂ | X₁          | Yes  | Yes   |
| Control     | O₂X₂O₄ | X₂          | Yes  | Yes   |

*X₁ = Using Interactive Multimedia
*X₂ = Using Conventional Learning

The method that used in this study is a quasi-experiment with pretest to posttest control group design. The pretest method was given to college students to determine their learning achievement before given the application multimedia to experiment science during learning process for the experimental group and also the implementation multimedia and learning feedback from a list of several questions.

The application of the multimedia in science experiment divided to three forms of multimedia teaching materials, there are static images, videos, and animations that was conducted by applying the formative tests. To measure students' thinking skills, it can be seen from the number of percentages based on critical thinking indicators, namely focusing on a question (KBKr1), analyzing arguments (KBKr2), asking questions and answering questions about clarification and challenging (KBKr3) and create and weigh values (KBKr4). Giving student feedback is seen from the quiz results. The
The control class is only given a quiz without a multimedia application. Quiz scores obtained at the end of the last meeting. After the learning process ends, students are given a questionnaire about learning feedback. Descriptive statistics and ANOVA were given to analyze the data which have been collected.

3. Results and Discussion

According to the results of the analysis using the t-test no significant differences were found between the pre-test scores (t (120) = 0.277, p > .05). However, a significant difference was found between the mean post-test scores (t (120) = 0.026, p <0.05). Table 2 shows the results of two ANOVA factors regarding the level of significance of changes in pre-test and post-test scores of students in the experimental and control groups regarding critical thinking.

| Source                      | F    | Sig. |
|-----------------------------|------|------|
| Group (Experimental/Control)| 4.09 | .046 |
| Group*Measure               | 7.51 | .007 |

Table 2 shows that there are significant differences in student achievement between the experimental and control groups. This data shows the effects of the application of laboratory multimedia and repeated measurements factors on student achievement (F (1,120) = 0.07, p <0.05). These findings indicate that multimedia in science experiment activities conducted with multimedia is more effective than laboratory activities that use ordinary experiments without using multimedia.

As an alternative learning media, the advantage of multimedia teaching materials in experimental science is being able to simulate visual experiments through unique animations or moving images, creating good science concept scenarios to increase student interest in learning. So students can better understand the context of learning science quickly.

In practice, teaching materials using multimedia must be creative, innovative and simple and show science content critically. This multimedia learning must be able to solve important and difficult points for the smooth teaching. this learning be able to explain scientific theories and phenomena that are difficult for students to understand [17-19]. The results of the study to see the percentage of student critical thinking are presented in Figure 1.

![Figure 1](image.png)

**Figure 1** Graph students' critical thinking results based on percentage values

Based on the image it was found that student groups were learning through multimedia material in learning science has a higher level of critical thinking than the group that learns conventional. The smallest difference in critical thinking skills occurs on KBKr1 followed by KBKr2 and KBKr4. Use multimedia on this learning can help students in learning processes that cannot be seen directly during learning in classes, such as acid-base molecular shapes and designs electromagnetic induction. This is
in line with a statement which states that the use of multimedia learning can help students visualize objects and a process that cannot be displayed in a manner directly in class [20]. Further explained that the availability of technology makes it possible students get a learning experience richer during class through use simulation of the concept being studied.

Multimedia applications are expected to make a positive contribution. Besides the teacher the role of students is also important where they must participate in designing innovative learning using multimedia. To avoid using multimedia as another whiteboard and teach students only through video, teachers must focus on guiding students to analyze science phenomena and train students to think critically, deepen understanding of science concepts, processes, teaching students to analyze and solve problems.

**Table 3 Percentage of Students to Written Feedback Responses Provided**

| Number | Percentage (%) | The content of written feedback |
|--------|---------------|---------------------------------|
|        | Experimental  | Control                         |
| 1      | 93,5          | 87,5                            | Remember, animation must be in accordance with the theme |
| 2      | 80,5          | 75,4                            | Remember, images with explanations must be adjusted |
| 3      | 83,8          | 70,0                            | Please check the shape of the compound molecules |
| 4      | 78,5          | 75,5                            | Please check the calculation |
| 5      | 80,5          | 74,5                            | Please check the calculation |

One form of simulation from the use of multimedia as a learning material in a science experiment after feedback can be seen in the following Figure 2.

**Figure 2** Screenshot virtual chemistry and physics laboratory software after feedback in acidic and basic materials and electromagnetic materials

Simulations can make abstract science phenomena more accessible to students. For example, understanding science phenomena such as the acid base process and electromagnetic are difficult for some reasons. the process of making acid-base multimedia through the application of feedback
becomes more interactive and easier for students to understand because it fits with everyday material. Application multimedia in experiments has the potential to make abstract scientific concepts, such as processes electromagnetic induction, more accessible and visible to students.

Based on observations, it shows that the experimental class is more active in answering questions than the control class. This is caused by the effect of feedback from students through multimedia teaching material in the experimental class. As expressed by [21-23] that the continuous and integrated application of multimedia teaching materials during the teaching process will bring positive changes in the classroom environment. Shah, Widayat and Widiyatmoko [24-26] added that the through multimedia teaching material can be improve students learning process and achievement.

### 4. Conclusion

The conclusions that can be drawn from this study are as follows application of multimedia materials on the science learning developed is attractive appearance, material in the form of facilities coherent and systematic, clear practice videos, easy tutorials to follow, and interactive evaluations which is combined so that it is practically used and become one of the solutions to practice in schools. Level of implementation of learning by using multimedia experiment and overall support device fully implemented so that it can be said practical and effective. Student responses within learning using multimedia inside science experiments are positive so students learn easily, fun, interested and motivated to learn easily to do lab work and challenging to study harder. Student learning outcomes show that by using multimedia in classical science experiments in text can improve student learning outcomes. These findings and suggestions the study can be a useful reference for multimedia designers and science teacher candidates.

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