The use of Virtual Analogy Simulation (VAS) in physics learning

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Abstract. The purpose of this research is to explore the use of VAS software in electrical dynamic learning in junior high student, so as to obtain an overview of this software consistency in help students build a scientific conception. This research was administered via research and Development (R & D) with the design of embedded experimental models. The respondents which were involved in this research were 60 students of ninth grade in one of junior high schools in Kudus central java. The improving process of students’ concept is examined based on normalized gain analysis from pretest and posttest scores. The result of this research shows that there was difference between learning using conventional learning (power point software) with VAS software. VAS is more effective to assist students in understanding the electrical dynamic concept shown with N-gain of 0.36, or 36% were included in the medium category, whereas the conventional learning with N-gain of 0.28, or 28%.

1. Introduction

Physics is the science that studies the science of natural laws and their application in life. The nature of physics is abstract concept, there is nothing concrete. Abstract concepts are difficult to imagine that making the student difficulties in studying physics concept. This makes the students think physics is difficult and boring, unless if associated with everyday life.

Nowadays, science and technology develops rapidly. The use of ICT will make the learning process more motivating and challenging, facilitating the teachers and students in teaching-learning processes [1-3]. In broad-spectrum, the use of computer by teachers in schools is restricted on Microsoft Power Point program to enhance students’ understanding of the concept. Therefore, the skills obtained by the students are route learning. It is in order with Prince [4] and Bobadilla [5] who stated that at the moment, learning tends to be based on memorize the theories without utilize students’ experiences.

Based on the questionnaire distributed to junior high school students in Kudus, central java, the score obtained by students in the test is still poor because of some reasons such as bad class conditions, students’ poor mathematics skills, route learning, and demonstrations without showing a video or animation that support the explanation of the concept. In fact, sufficient amount of computer media are available in the laboratory and the classrooms.

The use of analogy as a cognitive aid in learning has been emphasized. It may be possible to produce meaningful learning via analogy. Many researchers emphasized the power of analogies in education [6-14]. Mason [10] stated that analogies were found useful for: 1) organization of new knowledge; 2) the
access to, and retrieval of information previously stored in memory; 3) the overcoming of misconceptions; 4) the creation of new schemata.

Several previous studies suggest that students have misconceptions about gravity and inertia. The results also point out that bridging analogies are useful in overcoming the students' misconceptions about gravity and inertia [15]. Also Clement [7] suggest that student were practical generating several types or interesting argument during debate, such as making of analogies and excessive case of their own, explanations via microscopic model (simulation), giving real example, arguments by inappropriateness from lack of causal effect, generation of new scientific question and even spontaneous generation of bridging analogies.

In computer sciences, since the concepts are so abstract, it is observable that these concepts are almost unattainable to be supposed with sense organs. Some dissimilar aids are needed for them to be understood. Because there are so many dissimilar hardware components and there are many subcomponents of these components, experts sometimes infer them another way from each other, which cause students to shape “misconceptions” [6] since misconceptions can delay understanding they should be overcame by analogies. The use of analogy is one of the methods that can be used in computer technologies because learning was difficult through visual and real-life resources so will be very effective. It has been reported that if students are enthusiastically concerned and can join the analogy and activities, their misconceptions reduce [6,16].

In this reverence, for some researchers computer-based analogy can help students with a precise visualization of the correlation among the familiar and the new phenomena within a single multimedia software environment. When students can come up with an exact mapping between the analogy and the target, their analogical analysis can be supported by an active and visualized correlation of two structural associations [17].

Based on these considerations, researchers did research to develop analogy based in electric dynamic topic using computer simulation. Computer simulations have special value as they offer a high potential for interactive learning in all domains of science education [18]. A significant amount of previous research has demonstrated the effectiveness of computer simulations in learning. A good number of these studies have alert on the success of computer simulations in sustaining students’ understanding, inquiry and reasoning skills [19-24]. The examples of analogies found in a popular text example Halliday, Resnick & Walker [25].

2. Methods
This type of research is a research & development (R & D). Products developed in this study a computer simulation with bridging analogy (Analogy-Based Simulation) to the concept of dynamic electricity, here in after referred to VAS. Development model used by researchers is the adaptation measures proposed development studies by Borg and Gall [26] and Thiagarajan [27]. The following design scheme described in figure 1.
At this stage of VAS applications that have been developed (quantitative phase) used a Quasi Experiment with research design using Pretest-Posttest Control Group Design. The design is shown in figure 2.

**Figure 1.** The design of research

**Figure 2.** Control Group Design

Note:
- : Pre-test = post-test
- : Physics learning use VAS software in experimental group
- : Physics learning use power point without analogy in control group

The population in this study is the seventh grade students of Junior High School (SMP) in Kudus, central java, which consists of eleven classes with the average number of students in each class are 30 students, while the sample is two of grade IX in the school with 60 students.

Processing and analysis of quantitative data using statistical test with the following steps (1) The development before and after learning was calculated by computing normalized gain equation \( g \). (2) Test the difference made by using t-test of one tail. The purpose of hypothesis testing is to find a significant difference between the increases in N-gain in the control group with the experimental group. Normalized gain criteria which proposed by Hake [28] can be referred in Table 1.
Table 1. Normalized gain criteria.

| Criteria          | \(<g>\) ≥ 0.7 | 0.3 ≤ \(<g>\) < 0.7 | \(<g>\) < 0.3 |
|-------------------|---------------|---------------------|--------------|
| High              |               |                     |              |
| Moderate          |               |                     |              |
| Low               |               |                     |              |

Result development of Virtual Analogy Simulation (VAS) that will be used in the study can be described here. AVS provides an example of analogy in the subject of dynamic electricity; teachers can use the analogy of a water bath to explain the concept of an electric voltage. AVS give simulation/animation for electric dynamic concept to give explanatory models, simulation (computer animation) and subsequent bridging analogies were fruitful and important in producing the gain achieved. VAS production process is done by taking pictures, video collections or from the internet, then integrates them with images, animations, text, video and sound. The process of assembling images, animation, video and text is done using Macromedia Flash 8 program. From the overall validation done by the subject experts and media experts the result is a very good average with some improvements to be done to perfect the VAS program. Improvements made include reducing the amount of text, adding animations to motivate students more. The simulation shown on figure 3.

Figure 3. (a) Simulation of analogy of electric current flows like water system, (b) Simulation of analogy of An emf device is a charge pump and (c) Simulation of electric resistance (Ohm’s law)
3. Results and Discussions
The results of mastery of dynamic electricity concept are presented in Figure 4. Diagram presents the mean percentage of pretest scores, posttest, and N-gain among the experimental and the control group.

![Figure 4](image)

**Figure 4.** The comparison of mean percentage of pretest, posttest, and N-gain for both groups.

Learning for electric dynamic concept by using VAS software was implemented in three sub-concepts that should be discussed: the definition of different potential (how battery work); electric current and Ohm’s law. The results of the normalized gain analysis of each topic for two groups are presented in Table 2 and table 3.

**Table 2.** Normalized gain recapitulation in each sub-concept for experiment group.

| Sub-concept | Average Score | <g> | Criteria |
|-------------|---------------|-----|----------|
| 1           | 2.03          | 5.77| 0.53     | Moderate |
| 2           | 0.67          | 3.27| 0.58     | Moderate |
| 3           | 0.70          | 4.00| 0.63     | Moderate |
| Overall     | 3.40          | 13.03| 0.36    | Moderate |

**Table 3.** Normalized gain recapitulation in each sub-concept for control group.

| Sub-concept | Average Score | <g> | Criteria |
|-------------|---------------|-----|----------|
| 1           | 2.07          | 5.27| 0.45     | Moderate |
| 2           | 0.57          | 2.93| 0.53     | Moderate |
| 3           | 0.87          | 2.83| 0.36     | Moderate |
| Overall     | 3.50          | 11.03| 0.28    | Moderate |

Based on Table 2 and table 3, the results established that both group promoted deep understanding of difficult scientific concepts and it helped students to enhance these concepts. There is a gradually enhance in students’ concept at each sub-concept with similar normalized gain scores and they can be included in the moderate category. As found in earlier research [6, 7, 10, 13, 17, 18, 19], those studies also showed the identical results that learning with analogy use microscopic model (virtual computer simulation) is able to improve students’ concept. The reason is the use of analogy with computers simulation in the learning process will motivate students to interesting explanations via microscopic model (simulation), giving real example of principle, arguments by incongruity from lack of causal effect, generation of new scientific problem related to the lesson and even spontaneous generation of bridging analogies in order to understand knowledge, so that students will be more active during the learning process. The findings shown that when analogical instruction with VAS is used in a systematic
manner, students’ understanding of electric dynamic concepts and elimination of misconceptions is more enhanced than with conventional instruction.

To know is there any difference in the results of N-gain among the experimental and the control group performed the t-test, then the t-test technique used is the one tailed t-test is the right side. Based on the results of the calculation of \( t_{\text{calc}} = 1.731 < t_{\text{table}} = 1.677 \). This suggests that the proposed hypothesis Ho is rejected, it means the application of learning with VAS on the dynamic electricity concept can more improve mastery of concepts than the conventional learning. Ugur [13] shows that when analogical instruction is used in a systematic manner, students’ understanding of electric concepts and elimination of misconceptions is more enhanced than with traditional instruction. Duit [9] also stated that analogical analysis can aid make conception and problem solving. ÜNLÜ [24] also report the findings that the teaching in which the analogy-based simulations were used with laboratory activities together provided with the students in better understanding the electricity topics. When the fact how the motivation is important is taken into account, which one is more effective in increasing students’ motivation-the simulation method or the laboratory method should be suggested as for the further research.

4. Conclusions
Based on the research that has been conducted, it was concluded that the use of VAS in electrical dynamic concept for junior high school students is able to improve students' mastery of dynamic electricity concept with moderate normalized gain score in each sub-concept learnt. Based on the hypothesis test using one tailed t-test, it was found that the use of VAS software can more improve mastery of concepts than the use of conventional learning (power point software).

The findings of this study showed that the teaching in which the analogy-based simulations were used with simulation activities together provided with the students in better understanding the electricity topics. To make real abstract concepts and to have full of understanding of the activities analogy could be used together for other concepts in other studies. When the fact how the motivation is important is taken into account, which one is more effective in improving students’ motivation, the simulation method or the laboratory method should be recommended as for the further research.

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