Preliminary Design of ICI-based Multimedia for Re-conceptualizing Electric Conceptions at Universitas Pendidikan Indonesia

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Abstract. Interactive Conceptual Instruction (ICI) based Multimedia has been developed to represent the electric concepts turn into more real and meaningful learning. The initial design of ICI based multimedia is a multimedia computer that allows users to explore the entire electric concepts in terms of the existing conceptual and practical. Pre-service physics teachers should be provided with the learning that could optimize the conceptions held by re-conceptualizing concepts in Basic Physics II, especially the concepts about electricity. To collect and to analyze the data genuinely and comprehensively, researchers utilized a developing method of ADDIE which has comprehensive steps: analyzing, design, development, implementation, and evaluation. The ADDIE developing steps has been utilized to describe comprehensively from the phase of analysis program up until the evaluation program. Based on data analysis, it can be concluded that ICI-based multimedia could effectively increase the pre-service physics teachers' understanding on electric conceptions for re-conceptualizing electric conceptions at Universitas Pendidikan Indonesia.

1. Introduction

Since 2012, researchers have been developing an integrative learning model about Interactive Conceptual Instruction (ICI) based Multimedia. The ICI based multimedia is more emphasis on meaningful learning of physics to re-conceptualize students' conceptions about electric conceptions in the Basic Physics II. The electric concepts may possibly consist of: Coulomb force, electric field, Gauss's law, electric potential, the electric dipole, equipotential electric field, and electric flux. The entire electric concepts have been approached with the main concept of the electric field. The aim of this approach was to understand the electric concepts for the pre-service physics teachers who studied the electric concepts regard to the electric field [1, 2]. The main point while discussing about electric potential (V) concept [3], the researchers emphasize the relationship between electric potential to the electric field via the conceptual relationships as given by

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$$V = -\int_{r_1}^{r_2} \vec{E}\, d\vec{r}, \quad (1)$$

The Equation 1) shows that the concept of electric potential is closely related to the concept of electric field where the higher potential of a charged particle, the electric field at the same point would be lower. If pre-service physics teachers were only studying the relationship between the concept of electric potential and a scalar of electric field, the concept of vector was not going to occur as given by

$$V = E.d, \quad (2)$$

By utilizing Equation 2), pre-service physics teachers would not realize that the relationship between the electric potential is not only comparable equally strong or equally weak, but also rather on the relationship that took into account the concept of electric field as a vector potential and approached with the concept of directional derivative. Emphasis on the concept of electric field as a vector and attention to all the signs and the existing mathematical symbol (e.g. symbol "-" in Equation 1) affected on reconstructing the concepts that already exist became more comprehensively. The highlighting of the concept was referred to in the link between electric potential and the electric field. The conceptual learning of electric potential and electric field was not taught separately and sequentially but by linking these two concepts directly. The importance of the relationship between the concepts of utilizing an electric field turned into the development of ICI-based multimedia.

The initial design of ICI-based multimedia in the form of a multimedia computer that allowed users to explore the whole electric concepts through the conceptual and practical aspects has been developed. In the early steps, students easily were to explore the electric concepts by using the ICI-based multimedia in the home and classroom. This is caused by having been given and installed the multimedia in to students' laptop. Nevertheless, students were occasionally not quite understands the instructions for operating the simulation and video which were developed in the ICI-based multimedia. With the purpose of students sporadically utilize ICI-based multimedia regardless of the order of concepts that should be learned.

2. Methods

The ADDIE model of research methods has been utilized to develop ICI-based multimedia [4], which includes the steps of: Analyzing, Design, Development, Implementation and Evaluation. The development of ICI-based multimedia through ADDIE model has been applied to the seven pre-service physics teachers who took second time the course, as consequently the students were able to be identified hold the existing concept. The research was accompanied in the second semester of the academic year 2014/2015 at the Program of Physics Education, Faculty of Mathematics and Natural Sciences Education, Universitas Pendidikan Indonesia. The study involved three lecturers, three laboratory assistants and one research assistant. Each elements who were involved had the following roles: 1) first as a lecturing model (a lecturer who conducting classroom's learning) and two other lecturers as an observer and reviewers, 2) all laboratory assistants set carefully up the equipment and materials for developing ICI-based multimedia and 3) research assistant's role documented and recorded learning activities.

The non-test instrument which was utilized in observing the implementation of the ICI-based multimedia to the pre-service physics teachers was observation-sheet via Liekert Scales (4 scales). Moreover the instrument has been implemented to obtain the data about the learning process namely Students' Worksheet (SW) and Exploration Sheet of the PDEODE*E [5, 6, 7].

3. Results and Discussions

The development of ICI-based multimedia on the electric concepts was more emphasis on the conceptual approach to facilitate pre-service physics teachers more comprehensively understanding the concepts. The multimedia development has been utilized via ADDIE developing model which

included development steps, 1) Analyzing, 2) Design, 3) Development, 4) Implementation and 5) Evaluation. In detail, multimedia development is discussed as follows.

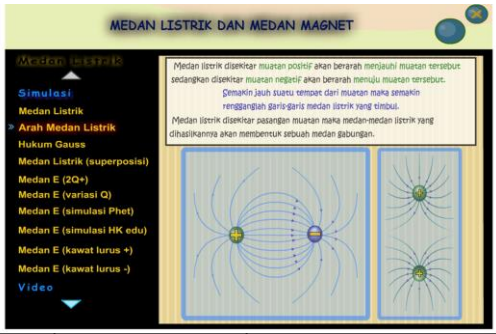
3.1. Analizing

The analyzing phase was a process of needs assessment such the phase to identify the research problems (needs) and to perform tasks' analyze. The output of the analyzed process was more emphasis on conceptual teaching through the use of multimedia computer. Based on further analysis, researchers have been obtained the development of learning models on Interactive Conceptual Instruction (ICI)-based Multimedia. Analyses were also conducted on "SAP" or learning plan and syllabus of Calculus-based Basic Physics II at that moment researchers totally conducted a fundamental revision of the "SAP" and the existing syllabus. The "SAP" and syllabus have been developed based on a conceptual approach through an Interactive Conceptual Instruction-based Multimedia. With the existence of a fundamental revision of the curriculum and syllabus, the analyzing process produced the developing multimedia shown more emphasis on the concept of an electric field.

3.2. Design

This step was known as making blue-print, similar with the building before it is built there should be a design on paper first. Design in question is the design of multimedia used in learning. ICI-based multimedia design concept focused on electric concepts especially in the main concept of electric field via simulations and videos. This multimedia design includes physics concepts such as; electric force, electric field, Gauss' law, electric potential, equipotential electric field, electric flux and so forth. An example of a multimedia design developed in the ICI-based multimedia in the form of storyboards was given follows.

Tytle : Electric Field Frame : 2
Frame Name : The Direction of Electric Field Page : 2



Explaination of Frame	Naration	Explaination of Figure and Simulation
The second page shows the title at the top and the name of the frame on the left with a check list and explanation of the concept of the image and the direction of the electric field in the right position.	No sound	Figures of lines of forces and direction of the electric field on the same two charged objects (positive - positive) and opposite in sign (positive - negative). Simulations show the direction of the field of positively charged object to negative.

Figure 1. Storyboard of an ICI-based multimedia.

3.3. Development

Development phase is the process of realizing the blueprint or design had become a reality. This means that at this step everything needed or that would support the learning process should have been well

prepared. As an example of the design, the development phase has been prepared based on multimedia shape as the following example.

Figure 2. Homepage of ICI Based Multimedia on Electric Field.

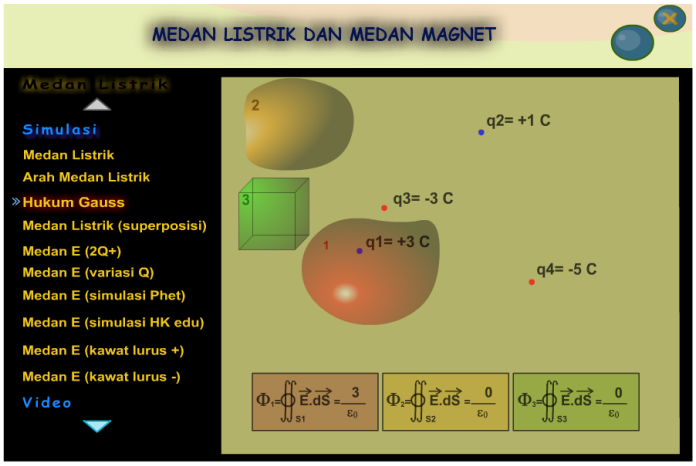


Figure 3. An example of simulation on Gauss law.

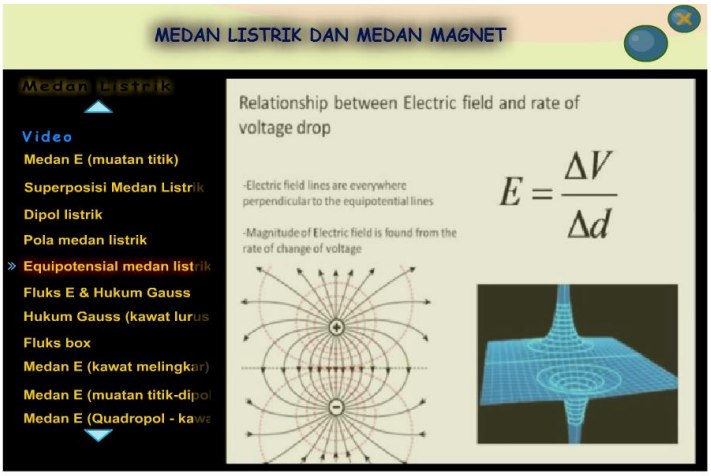


Figure 4. An example of video on explaining equipotential Law.

The development was undertaken involving the development in multimedia design and multimedia content. Multimedia design that was developed using the program Flash MX and Java Applet were

independently developed by the researchers and there were also downloaded from the Internet as PheT and others.

3.4. Implementation

Implementation is the real step to implement a learning system that is being created. That is, at this stage all that has been developed is installed or set in such a way appropriate to the role or function to be implemented. Once the product is ready, it can be tested-piloted through small group then evaluated and revised. Then the test can be performed on a large group then re-evaluated and revised so as to produce a final product that is ready to be disseminated. But at the initial design based multimedia ICI is only done on a small group trial and evaluation. Here is an example of the implementation of the ICI-based multimedia in teaching Physics II.

Figure 5. The Implementation of ICI-based Multimedia on Basic Physics II.

3.5. Evaluation

Evaluation is the process of learning to grasp whether the system is being built successfully, according to initial expectations or not. Evaluation step was able to be carried out at each of the four steps over the so-called formative evaluation, because this phase model was evaluated in implementing process. For example in the implementation phase needed expert reviews to give input to the draft that was being made. This could be seen in the use of aspects of ICI originally based multimedia could be used at home and in the classroom. The classroom course and lecturers guided the electric concepts in the order to be understood by the students. In addition, multimedia was also used as a focus on the learning activities in the earlier phase. The effectiveness of learning using ICI-based multimedia was able to be evaluated by using test items namely Field Conceptual Change Inventory (FCCI) as understanding (U), misconceptions (M), no understanding (NU), partial understanding and uncoddable (UC) the electric conceptions for re-conceptualizing the concepts to be more scientific conceptions (or conceptual change process as given by Table 1) and better prepare in exploring the next learning activities.

Table 1. Frequency and proportion of students' responses for test items.

Category	Electric conceptions				%
	Pre-test (f max. is 91)		Post-test (f max. is 91)		Conceptual
	F	*%*	*F*	*%*	change
U	13	14,29	30	32,97	+18,68
M	23	25,27	7	7,69	-17,58
NU	28	30,77	10	10,99	-19,78
PU	21	23,08	38	41,76	+18,68
UC	6	6,59	6	6,59	0

The data shows that the students' understanding increase (positive "+" sign) from pre-test to post-test. It means that the ICI-based multimedia could effectively increase the learning process on electric conceptions and the same time the model could re-conceptualize the students' conceptions.

4. Conclusion

Based on the analysis data, it can be concluded that the development of ICI-based multimedia on the electric conceptions through ADDIE developing model (Analyzing, Design, Development, Implementation and Evaluation) was able to effectively increase the pre-service physics teachers understanding on electric conceptions. The ICI-based multimedia has been developed by using software of Flash MX and Java Applet.

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