Developing video-based learning for the application of ohm’s law towards conductive transparent layer

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Abstract. This study aimed to produce video-based learning as a media for enhancing students’ knowledge of the application of Ohm’s Law on a technological context using a conductive transparent layer. This research used the ADDIE model that consisted of five stages, namely analysis, design, development, implementation, and evaluation. In testing the quality of video, questionnaires were used as the research instrument. Based on the results of data analysis, the media expert gave a score of 3.91, whereas the material expert’s assessment resulted in a score of 3.80 and was included in the "very good" category. The assessment of the physics subject teacher resulted in a score of 3.05 which was categorized in the "good" category. However, there were different scores in the product trials tested towards students of MAN 1 Palu. The initial trial of the product to 9 students received a score of 3.25, which was categorized as "good". After making improvements to the video, the implementation was limited to 10 students only, and the results of the questionnaires indicated an increase in the score to 3.57 which was categorized as "very good". Based on the findings, it shows that the video-based learning is suitable for use in physics learning.

1. Introduction
The curriculum 2013 requires an educational process that provides opportunities for all students to be able to develop their potentials in the aspects of attitude (affective), knowledge (cognitive), and skills (psychomotor). These aspects should be further developed as they hold a critical role in facing challenges and competition in the current era of technological advancement [1]. The subjects in the 2013 curriculum which are very closely related to the advancement of science and technology are science-based subjects. Science refers to the knowledge which relates to a process of discovery based on a collection of scientific facts, concepts, and principles. Along with its development, science has a positive impact on the creation of technology to assist humans in daily activities [2]. Among the discoveries in the field of science, the application which is close to everyday life activities is a conductive transparent layer.

A conductive transparent layer, commonly known as Transparent Conducting Oxide (TCO), is a conductive and transparent material superimposed on glass. The application can be found on solar cells, LCD or plasma screens, smartphone screens to light sensors [3]. In fact, it is stated that a conductive transparent layer is an important component for making various photonic-electronic devices [4,5].

The large benefits of this transparent conductive layer are deemed necessary to be introduced to the science learning process in schools. Rohyani et al revealed that the goal of teaching technology to
students was to make it easier for students to understand the relationship between issues that arise in society, especially those related to scientific concepts, and to adapt with future community life especially in 21st Century Era [6]. According to Maturradiyah and Rusilowati who conducted an assessment of physics teaching materials in Senior High School in Semarang, it shows that only about 2.90% of contains material related to science, technology and society [7]. This shows that the learning process in schools still focuses on the content dimension of the learning process based on the context of science applications. The impact of this situation, of course, is that students' ability in scientific literacy is low. Therefore, the use of a conductive transparent layer is expected to be an innovation in the learning process, especially in physics, which is related to enhancing students' knowledge regarding facts and concepts so that it can improve students' scientific literacy skills.

The conductive transparent layer itself has properties as a conductor. One way to determine the ability of a conductive transparent layer to conduct electricity is to find the value of resistance. Rahmasari stated that the resistance value of TCO material could be obtained through the experiment of Ohm's Law [8]. Ohm's Law Experiment is included in the physics material taught at the Senior High School/Islamic Senior High School level. Ohm's law states the proportion between current (I) and voltage (V), as well as the size of the ratio of the two, refers to the resistance value of a conductor which has a constant temperature. To determine the resistance of the conductive transparent layer, it is done by measuring the value of the current and voltage.

However, it is realized that in constructing materials related to Ohm's Law experiments, the lesson needs to be delivered in an attractive manner. This is believed to be so because students have shown low interest in learning it. For students, physics is a subject which is considered as difficult with an abstract theory and too many formulas that must be memorized. In addition, the teaching methods are less varied and thus they are unable to build a learning environment which is not boring. Moreover, based on the results of observations at MAN 1 Palu, it was found that physics materials related to practicum activities were rarely implemented due to limited laboratory facilities. Therefore, learning media is critically needed so that learning physics material regarding Ohm's Law applied to the conductive transparent layer can be implemented even with limited facilities.

The appropriate learning media chosen was video playback. According to Maryono, video playback was a combination of audio and visual technology which was combined to produce a dynamic and interesting program [9]. Other benefits of using video media are: (1) the video can be played repeatedly in accordance with the students' learning speed [10]; (2) practical means of displaying activities related to demonstrations [11]. In the process of learning science, demonstration activities are closely related to practical activities, where students have the opportunity to learn directly from the demonstrations delivered by the experts; (3) last but not least; it can stimulate student motivation and enhance student learning outcomes [12–14].

Therefore, in this study, the objective of this research was to produce video-based learning media on the application of Ohm's law material towards a conductive transparent layer. As for what distinguishes this research from others is not only developing learning with ICT (Information Communication and Technology) as a tool to deliver materials, but also developing products in the form of compilers of a technology that is close to students daily life. The delivery of material through video media featured engaging elements, such as animation, direct material explanation by researchers, of Ohm's Law practicum activities. Activities related to practicum activities in this video indirectly provided experiences for students as though they were in a real practicum atmosphere.

2. Method
The type of this research was a Research and Development (R & D). The Research and Development method is utilized to produce specific products, as well as testing the effectiveness of the products [15]. This research and development of educational video playback referred to the ADDIE model that consisted of five stages, namely Analysis Design, Development, Implementation, and Evaluation. This model was chosen because of its systematical process that was easy to follow [16]. As the details of research stages can be observed in Figure 1.
The research was carried out in two places, namely Madrasah Aliyah Negeri 1 Palu as the test site for the video media products to display for the students, as well as the Physics Laboratory as a place for creating conductive transparent layers and as a location for video shooting. In addition, the method of making a conductive transparent layer was determined, then the tools and materials were prepared. The method used was spray pyrolysis [17–19] with a concentration of 0.7 M precursor solution.

As a part of development research, the instruments used in this study were questionnaires given to material experts, media experts, teachers and 19 students. The type of questionnaire used in this study was a closed questionnaire which had answers that had been provided and it did not provide opportunities for respondents to add additional information [20].

The assessment questionnaire which had been filled in by the validators, teacher, and students was then analyzed. The analysis technique used was the calculation of the average value based on the Likert scale assessment. As for calculating the average value of all statements in the questionnaire, the following equation was used [21]:

\[
X = \frac{\Sigma x}{n}
\]  

(1)

Note:

\(X\) : Average score in each question item
\(\Sigma x\) : Total score of all the evaluation in each question item
\(n\) : Number of question item

The score obtained was then converted to qualitative data as accordance with Table 1 [22].

![ADDIE Model Stages](image-url)
Table 1. Likert scale category

| Score          | Criteria          |
|----------------|-------------------|
| $3.25 < X \leq 4.00$ | Very good (VG)   |
| $2.50 < X \leq 3.25$ | Good (G)         |
| $1.75 < X \leq 2.50$ | Poor (P)         |
| $1.00 < X \leq 1.75$ | Very Poor (VP)   |

3. Result and Discussion

Video-based physics learning was the result of the learners' needs analysis at MAN 1 Palu. The needs analysis was obtained by conducting observations at the field and literature. The results of the field study provided information that there were several points which affected the physics learning process, and thus it became not optimal. Among them were: First, very limited teaching methods. Second, limited laboratory space and facilities. The third was that the teacher has not optimally explained the relationship between the physics concepts being taught which were relevant to everyday life. Therefore, the video presented conductive transparent layer as one example of technology product that was applied on learning process. The following Figure 2 displays the Conductive Transparent layer used in the Ohm's Law practicum within the educational video.

![Figure 2. a. ITO Glass; b. FTO Glass](image)

In general, the displays of video-based learning for application of Ohm’s Law were divided in three parts. They were Learning Introduction, Main Content, and Closing lessons. All the Materials in this video were delivered with animation and practicum experiments so that student would not get bored. As of the software utilized to enhance the video playback to stimulate students' interests in participating the learning and teaching activities was Sparkol Video Scribe and Wondershare Filmora 9. Sparkol Video Scribe is a software which displays materials with an effect of handwritten texts and interesting animations. Then, to insert elements such as audio and visual elements, Wondershare Filmora 9 was utilised for the editing as well. The following figures represent the video display which has been developed:

3.1 Learning Introduction
The introduction on this video displayed the beginning of an educational video and its appearance can be seen in Figure 3.

![Figure 3. Introductory display of physics educational video](image)
3.2 Main Content of the Learning Activities
The following are the main learning activities regarding the explanation of the material and experiments can be seen in Figure 4 and Figure 5

![Figure 4](image1.png)

**Figure 4.** The explanation of conductive transparent layer and its application

![Figure 5](image2.png)

**Figure 5.** Ohm’s law experiment

3.3 Closing of the Lesson
The following conclusions of the lesson can be seen in Figure 6.

![Figure 6](image3.png)

**Figure 6.** Conclusion of the lesson

After the video was created, a validation test was carried out to evaluate the quality of the video playback produced. The questionnaires were then distributed to material experts, media experts, teacher, and students. The results of the validation tests are displayed on Table 2 until Table 3.

| No  | Aspect         | Score | Category    |
|-----|----------------|-------|-------------|
| 1.  | Content Delivery | 3.75  | Very good   |
| 2.  | Linguistics    | 4.00  | Very good   |
| 3.  | Education Values | 3.67  | Very good   |
|     | Average Score  | 3.80  | Very good   |
Based on the feasibility test of the material expert, the average score for all aspects was 3.80, which was categorized in the "Very Good" category. The highest score obtained was in the linguistic aspect. The assessment indicator in this aspect was the use of language which made it easy to understand the flow of the material and the accuracy of the text of the story. This shows that the video media product developed was feasible to be tested in the learning process. Some suggestions were added in the video, namely: adding an explanation of the definition of the method in making a conductive transparent layer, clarifying examples of the use of a conductive transparent layer in everyday life, and adding instructions for measuring the voltage three times in the measurement process.

Table 3. The results of feasibility test from media experts

| No | Aspect       | Score | Category  |
|----|--------------|-------|-----------|
| 1  | Display Quality | 4.00  | Very good |
| 2  | Design       | 4.00  | Very good |
| 3  | Performance  | 3.75  | Very good |
|    | Average score | 3.91  | Very good |

As for the results of the feasibility test of media experts as mentioned above, Table 3 shows the average score for all aspects of 3.91, which was categorized as "Very good"; these aspects included the selection of animation which provided a complex picture to be concrete; suitability of proportional color and font size. Moreover, the display presented was clear and easy to understand. Apart from the aspect of display quality, the design aspect was also given the same high score. Design aspect indicators included media attractiveness, creativity, and innovation in learning, as well as the size or capacity of video media that could be stored in the form of data and be reproduced. The suggestions given were the need to synchronize the volume of the audio supporting animation with the audio of the researcher explaining the material.

According to Sugiyono [15], an important step in the development stage was product testing, which was done during the implementation. Product trials at the development stage were carried out to determine students' initial responses to the developed video media. In addition, students could provide suggestions for better videos to be tested on a wider subject. This opinion is also supported by Aldoobie [23] who stated that after developing course materials we were ready to run through the design, like a practice run or a pilot test to find the weakness of video then making some improvements. However, in this study, due to limited time and energy, the researchers tested the initial product on 9 students. Then, the video was improved and tested again at the implementation stage in the classroom. The implementation of video media was limited to small group trials with 10 students. The questionnaire used in the initial product trial was the same as the small group trial with 15 statement items.

The statements contained in the questionnaire consisted of several indicators, namely the attractiveness of the appearance, the ability to understand the material, the ability to stimulate video interest and motivation to learn, the relationship between physics concepts and the development of science and technology, and the ability of video as an alternative learning media. There were some suggestions for student improvement on video media, namely: slowing down the transition at each video frame and minimizing the sound effect of interference or commonly called noise. Based on the suggestions given, several revisions were made to improve and clarify the proposed sections. A difference on students' scores between before and after the revision of the video can be seen in Figure 7.
The results of the questionnaire show an increase in the score, from 3.25 which was in the "good" category to 3.57 which was categorized as "very good". This means that students showed a positive response to this video media for use in class. In addition to giving response questionnaires to students, physics teachers were also given an assessment sheet to determine the feasibility of developing video media. The results of the assessment by the teacher can be seen in the following Table 4.

| No | Aspects                | Score | Category |
|----|------------------------|-------|----------|
| 1. | Display Quality        | 3.00  | Good     |
| 2. | Design                 | 3.25  | Good     |
| 3. | Implementation         | 3.00  | Good     |
| 4. | Content Delivery        | 3.00  | Good     |
| 5. | Linguistics            | 3.00  | Good     |
| 6. | Educational Values      | 3.00  | Good     |
|    | Average Score          | 3.05  | Good     |

Based on the overall value of data analysis, the media can be stated to be suitable for use in learning. This is in accordance with the opinion according to Arsyad (2011), that a video was a suitable medium for various learning sciences, which was aimed at large or small groups, heterogeneous groups or even only one student [24]. Another research result related to the use of videos in learning also showed that the presence of video media added to the variety of learning and increased student motivation to learn [25]. Moreover, the advantages of video media developed in this research were related to the latest technology in which there was no video media that discussed conductive transparent layers in the physics learning process. In order for the students to understand the benefits of the transparent conductive layer, the researchers included elements of moving animation in the video, such as the ITO glass applications which can be found on smartphone touch screens and FTO glass applications which can be found on solar panels. From that, the video media would make it easy for teachers to conduct direct learning based on the needs of students related to their understanding regarding the conductive transparent layer material in Ohm's Law.

4. Conclusions and Suggestions

4.1 Conclusions

Based on the research conducted, the development of video-based learning media was produced in the application of Ohm's Law material on the Conductive Transparent Layer. In testing the quality of the educational video media, an assessment sheet in the form of a questionnaire was distributed to material experts, media experts, physics subject teachers and students for limited trials. From the results of data analysis, it can be concluded that this educational video is suitable for use in learning physics.
1. There is a need of further research regarding the effectiveness of the implementation of video media in learning process, so that the impacts on student learning outcomes can be examined.

2. More learning media should be developed, specifically in associating today's most recent technology products with the school subjects being taught.

4.2 Suggestion
There are several suggestions which the researchers wish to elaborate:

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