Development of Video Education using Problem-Based Learning (PBL) to Support M-Learning on the Kinetic Gas

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Abstract. The teaching materials in the form of video education using problem-based learning models (PBL) accessible via smartphones to support mobile learning (M-Learning) is developed. The kinetic theory of gases is chosen after analysing the needs of the students in the development of this teaching material. The Research and Development (R&D) and refers to the ADDIE development model (Analysis-Design-Development-Implementation-Evaluation) are used as the method of research. The learning videos that are applied in the smartphone apps conform to the stages of the problem-based learning model. The sequences are basic concept, problem definition, self-learning, knowledge exchange and evaluation. In the activities of the learning process, the steps carried out which are orienting problems, organizing students to learn, guiding individual / group experiences, develop and presenting work, analysing and evaluating problem-solving processes. The teaching material in the form of videos that has been developed is accessible via smart devices (smartphones) in the hope that they can be a source of learning in the process of mobile learning (M-Learning). The videos produced are validated by material experts, media experts and learning experts. The Materials Expert gave a score of 95.83 out of a maximum score of 100 with a very good interpretation. Media experts gave a score of 83.6 out of a maximum score of 100 with a very good interpretation. The learning expert gave a score of 89.4 out of a maximum score of 100 with very good interpretation. In addition to being validated, the resulting video was tested for the feasibility of its use by teachers and students. The teacher’s feasibility test scored 90.5 out of a maximum score of 100 with very good interpretation. The students gave a usability score of 87 out of a maximum score of 100 with very good interpretation. Based on the validation and feasibility tests, it can be said that the videos developed as learning material can be used for classroom learning.

1. Introduction
The development of information technology is very rapid in today’s world. Its development accelerated from the lower strata to the upper strata of society. The use of digital technology has become commonplace in everyday life, from waking up in the morning to sleeping in the evening [1]. It also has an impact on the learning process of students in school. The use of various digital media in learning in schools provides more meaningful learning. Among the media used are learning videos.

Video education are materials that provide audio and visual elements of good learning messages containing concepts, principles, procedures and knowledge translation theories to help understand learning material. Video is visible and heard (audio-visual) learning material that can be used to convey messages / topics [2]. It is said to be seen to hear because both hearing (audio) and visual / video (visible) elements can be presented simultaneously. Video is learning material that is packaged on videotape and can be viewed through a video / VCD player connected to a television monitor [3]. The use of learning videos has a positive impact on understanding and preventing the spread of disease [4]. A significant
positive effect of learning videos is also demonstrated on health knowledge literacy. The use of learning videos increases knowledge about health [5].

The right learning method is also important in addition to the right learning materials. The problem-based learning method is one of the many methods which shows a good influence on the learning process of students. The use of problem-based learning in learning improves students' intra-personal attitudes and teamwork [6]. Problem-based cooperative learning applied in the learning process improves the cooperative skills of students in an online learning environment [7]. A positive impact is also shown in the use of problem-based learning when used to teach physics [8]. In learning, students are encouraged to find themselves and transform complex information, to verify new information with what is already in memory and to develop it into information or capacities appropriate to the environment and time. This context conforms to one of the learning models which uses a scientific approach, namely problem-based learning (PBL).

Therefore, the authors are interested in conducting research on the development of problem-based learning physics learning videos for the high school student, in particular subject of kinetic theory of gases.

2. Method

The research method used in this study is a research and development method with a model developed by Dick and Carry, namely the development model consists of five steps; Analysis (analysis), design (planning), development (development), implementation (implementation) and evaluation (evaluation).

The learning video making mechanism is realized to produce physics learning videos using the steps of the ADDIE model as follows; Literature review and needs analysis, Program review, Selection of material to be presented, Objectives of the learning video, Analysis and preparation of required material, Research and collection of references related, Creation of a production schedule, Realization of scenarios, Realization of storyboards, Taking of photos, recording of stories, selection of background sounds, Evaluation validations, School test, Evaluation of learning videos.

3. Result and Discussion

The medium produced by this development research is a physics video learning the kinetic theory of gases in high school. The material in this learning video includes material on the ideal gas law, ideal gas equations, and equipartition equations. This learning video contains material for the formation of concepts by students, the application of concepts in everyday life and technology, as well as simple experiments that can encourage and motivate students to be able to perform simple experiments. This learning video that has been developed is 15 to 20 minutes long. Most of the videos shown in this learning video are taken from YouTube, but some videos were taken and made by themselves, as one of the hands-on activities.

This video uses a problem-based learning model that has 5 steps, namely orienting students to problems, organizing students to learn, orienting group experiences, presenting work and evaluation of the problem-solving process. In the first step, students are faced with a problem about a flying hot air balloon, what factors make the hot air balloon fly. In the next step, the students are divided into several groups to answer the problems that were presented in the video. Then, after the students were divided into several groups, each group observed and analyzed the video containing the experiments in the video. After the students analyzed the video, representatives from several groups presented reports related to the experiences of the video. In the last step, the teacher evaluates the learning by showing an explanatory video related to the experiments that were carried out in the video.

The feasibility of using the developed learning video can be determined by the validation of several experts (materials experts, media experts and learning experts) and high school physics teachers. The validation results obtained serve as a benchmark for reviewing the developed product both in terms of material, video display presentation, language used in storytelling and use of video in the learning process. After that, a test was conducted for the high school students who had studied the material on the kinetic theory of gases to find out whether the resulting product could increase the knowledge of the students by studying the concepts of physics in the material of the kinetic theory of gases. Figure 1
shows the screen capture of the developed learning video. The screen capture shows an experiment with Gay Lussac's law.

![Image of an experiment](image-url)

**Figure 1.** The screen capture shows an experiment with Gay Lussac's law.

The results of the validation of the learning video by materials experts showed a percentage of 95.83% with a very good interpretation of the value on several aspects. The highest percentage of material expert data is presented in the aspects of material accuracy, learning and skill development, and motivation. This shows that the physics learning videos that have been developed already meet the requirements as learning aids. Here are some suggestions given by material experts: The choice of words and phrases in the story should be improved, for example by using too many words now in the narration of the video; Addition of problems to the kinetic theory of gases; Subtract the liquid sample and add the gas sample.

The results of the validation of the learning videos by media experts showed a percentage of 83.6% with very good and good value interpretations. The highest percentage of data on media experts is presented in the experience aspect. This shows that the physics learning video that was developed met the requirements as a good learning aid in terms of appearance. The advice given by media experts is that more videos are made by themselves.

The results of the validation of the learning videos by learning experts showed a percentage of 89.4% with very good value interpretations in all aspects. The highest percentage of data on learning experts is shown in the motivation aspect. In this aspect, there are 2 indicators, namely to help students to conduct experiments and to prove abstract concepts in problem solving. This shows that the physics learning videos that have been developed already meet the requirements as learning aids. Suggestions given by learning experts are as follows: simple experiences of all tools and materials are attempted to be measurable; Dubbing and video must be in sync.

The results of the validation of the learning videos by the high school/vocational physics educators show a percentage of 90.5% with very good value interpretations in all aspects. The highest percentage of data by secondary / vocational physics teachers is shown in the material coverage aspect. In this aspect, there are indicators to encourage and motivate students in learning. This shows that the physics learning videos that have been developed already meet the requirements as learning aids. The suggestions given by high school physics educators / MA are, when a video on energy equipment can combine water and oil in order to stimulate students' curiosity; The service life must be distinguished between the formula and the image (illustration); Formula display must exist when read aloud.

### 4. Conclusion

The evaluation by materials experts, media experts and learning experts on the kinetic gas theory physics learning videos is very good, with average scores of 95.83%, 83.6% and 89.4%, respectively. And
supported by data on the average test score of 70% of students with good interpretation. Based on the results of the development carried out, it can be concluded that this physics learning video using the problem-based learning model meets the criteria and can be used as learning material for high school students.

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