Development of learning material in the form of a smartphone application on the subject of temperature and heat by inquiry-based learning (IBL) for physics high school subject

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Abstract. An smartphone application which are used as learning material on the subject of temperature and heat have been developed. The development process is carried out using research and development methods with reference to the Analysis-Design-Development-Implementation-Evaluation development model. The novelty of learning material that was developed was to use inquiry-based learning in the writing system. In addition, the learning material which developed also includes questions that refer to higher-order thinking. The results of the validity tests show the adequacy of the learning materials with the level of difficulty of the learning materials in high school. The learning material has been tested in SMA 16 Jakarta. The test results show an increase in learning outcomes shown by the gain score of 0.4.

1. Introduction

The form of learning material on smartphones has become a necessity in the industrial 4.0 era. Different types of software have been developed to facilitate student learning, including modules [1], Android applications [2], scratch application [3] and websites [4]. In addition, this learning material is very important in a learning process, especially for specific learning purposes [5]. The learning material developed gives students learning autonomy and improves their ability to solve problems [6]. Nowadays, as computer technology develops, it is very suitable for developing computer-based learning materials [7]. However, rarely found learning materials are developed using a certain learning approach. Specific subjects in learning physics such as energy, temperature, heat require an appropriate learning approach to achieve the learning objectives. One potentially appropriate to use is inquiry-based learning.

Inquiry-based learning (IBL) is based on John Dewey's philosophy that learning starts with generating strong curiosity among students. Learning physics which uses a research-based learning model actively involves students with concrete objects, gives students the opportunity to work in groups, encourages students to use observation skills, to develop problem-solving and participating in difficult tasks. The inquiry-based learning can support the building of skills that students should have, such as collaboration skills, ICT literacy, communication skills and information literacy [8]. inquiry-based learning also helps students gain high-level thinking skills, including logical, reflexive, metacognitive and creative thinking [9].

In this paper, we report on the results of software development that is used as learning material with a smartphone platform. The novelty of learning material that was developed was to use inquiry-based
learning in the writing system. In addition, the learning material which developed also includes questions that refer to higher-order thinking. The results of the validity tests is reported.

2. Methods
This research uses research and development methods, based on the ADDIE development model with stages of analysis, design, development, implementation and evaluation. The analysis was carried out by distributing questionnaires to high school pupils in the form of a questionnaire on the need for learning materials. According to the results of the analysis, up to 83% said they needed learning materials to cope with learning difficulties in physics. The analysis of topic of learning material is carried out in a study of the literature of books and the literature of physics on the subject of temperature and heat.

The design of the learning material is designed by compiling an overview of the content of the learning material by dividing it into three learning activities organized according to the learning stage based on the survey. The development of learning materials is done in the following stages; writing of learning materials, illustration design, cover design and finalization. iSpring Suite 9.7 is used to create learning materials. The implementation of the product is carried out for high school students and tests the feasibility of the learning materials developed through a questionnaire. The results of the questionnaire served as the basis for the evaluation of the learning materials developed and improved. The feasibility of the learning materials developed is determined by media experts, materials experts and learning experts.

3. Results
Research and development products are learning materials using research-based learning models with a smartphone platform. The learning material developed consists of three learning activities, including learning activities 1 on temperature and expansion, learning activities 2 on heat and learning activities 3 on heat transfer. Figure 1 shows the design of the home page of the learning material developed.

![Figure 1. The design of the home page of the learning material developed.](image)

The cover contains information on the title, the applied learning model, subject-related images, the UNJ symbol, the curriculum symbol and the grade level covered by the module. Figure 2 shows a mind map of the learning material developed. Mind maps contain topics, subtopics, and interrelationships between topics in the temperature and heat learning material.
Each learning activity uses inquiry-based learning steps, i.e. orientation, problem formulation, hypothesis formulation, data collection, hypothesis testing and the formulation of conclusions.

The feasibility test of the contents is done through a questionnaire of 30 questions covering the temperature and heat range of the material, the language, the presentation techniques. The results of the material feasibility test obtained a score of around 90 with a very decent interpretation.

The feasibility test of the media is done through a questionnaire of 26 questions covering display presentation, presentation of the language in the material, components of the learning material. The results of the material feasibility test obtained a score of around 85 with a very decent interpretation.

The feasibility test of the method of learning is done through a questionnaire of 30 questions covering presentation of learning materials, survey-based learning model, assessment of learning. The results of the material feasibility test obtained a score of around 82 with a very decent interpretation. The tests of learning materials on students and teachers obtained a score of around 89 with a very decent interpretation.

Based on the results of the field test, the material developed obtained information that the learning material developed was very appropriately interpreted so that it could be used as a learning resource. That the learning material developed is capable of increasing knowledge of the concepts of temperature and heat, the presentation of coherent material and is easily understood so that it stimulates motivation for critical thinking, communication language and arrangement of the components of the electronic module such as images, videos, colors, which makes the learning materials interesting in a coherent manner.

On the basis of the results of expert tests and field trials, it can be said that the learning material developed has been suitable for use as a source of independent teaching material and is able to increase the knowledge of students. In addition, students also receive pre-test and post-test questions. The results of the mean pre-test scores obtained were around 33.56 and the mean post-test scores were around 60.15. The results of the gain test obtained a score of around 0.40 with a moderate interpretation.

The novelty teaching material developed is to use the Inquiry-based learning (IBL) structure in the writing system. In addition, the presentation of the content of the material is packaged so that it conforms to the time. This makes it easier for students to understand the material.

4. Conclusion

Research and development of learning materials with the smartphone platform have been carried out. The results of the validity tests show the adequacy of the learning materials with the level of difficulty
of the learning materials in high school. The learning material has been tested in SMA 16 Jakarta. The test results show an increase in learning outcomes shown by the gain score of 0.4.

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