Developing android-based teaching material on temperature and heat using ADDIE model

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Abstract. Physics teaching materials are essential in supporting students to solve the problem and understand abstract physics concepts, if they are attractively designed. In this study, the researchers aim to create android-based teaching material on temperature and heat to increase students' interest and motivation. This study is the development research using the ADDIE model, which involves 5 stages. They are Analysis, Design, Development, Implementation and Evaluation. The research subjects were 20 students of class XI. The test and questionnaire analysis results indicated that the average score of the two validators was 3.66 and was categorized as "Very good." Assessment by the teacher depicted an average score of 3.45 categorized as "Very Good," and the results of the analysis of student response assessment obtained an average score of 3.25 which means "Strongly Agree". The results showed that the android-based teaching material developed is feasible as teaching material for students.

1. Introduction
The rapid development of science and technology has impacted almost every aspect of lifestyle today, and education is no exception. The 2013 curriculum has required teachers to possess the competence to master and utilize ICT (information and communication technology) to facilitate students in the learning process to be more effective and efficient [1]. The expected output of ICT-based learning is that students can compete and face global challenges in the future [2]. According to Shamim and Raihan, the use of ICT in education can be divided into two categories: ICT for education and ICT in education [3]. ICT for education refers to the development of ICT for learning, while ICT in education is the adoption of several components of ICT for use in the learning process. Referring to the statement, the teacher is free to choose what strategies will be used to integrate ICT in the classroom. However, it should be realized that although ICT is increasingly popular, not a few schools are still facing challenges, so they have not implemented ICT as a whole [4,5]. This is as found in SMAN 1 Tombusabora where teachers have not shifted their role as the primary source of information. For example, in the physics learning process, the teaching materials are still dominated by printed books. Those kinds of teaching materials will decrease students’ learning motivation because they tend to deal with formulas that are not attractively presented. Based on these conditions, researchers need to take advantage of the use of ICT to develop digital teaching material in the form of applications. Thus, students are motivated to learn, and teachers can be assisted by supportive learning resources to improve the quality of physics learning.
The technology that will be used as a media of digital teaching material is an Android-based smartphone. In fact, most students of SMAN 1 Tombusabora already have a smartphone. However, its use is more often for games and social media. Thus, researchers think it will be more efficient if the application can be installed on students' smartphones. This study is in line with a study conducted by Maulida et al which states that android-based teaching materials are feasible to use in learning and potential to improve students' critical thinking skills [6].

The topics that will be integrated in this teaching material are temperature and heat. The choice of temperature and heat material is also based on the research of Setyadi and Komalasari, which showed that 36.3% of students' mastery of temperature and heat material is still in the poor category [7]. Furthermore, according to research conducted by Febrianti et al., high school students had misconceptions about temperature and heat material by 57.85%. [8] Therefore, the purpose of developing digital teaching material is to produce an Android-based application that is easy to use and has an attractive appearance. This visual teaching material helps students introduce, enrich knowledge, and clarify the concept of temperature and heat material. In addition, this product is easy to operate for both students and teachers.

2. Method
2.1 Research Setting
This research was conducted in SMAN 1 Sindue Tombusabora. This school is one of the schools located in Donggala Regency, Central Sulawesi Province. The time needed for the development of teaching material to implement the product feasibility test is 9 months. The respondents in this study involved 20 students of class XI SMA Negeri 1 Sindue Tombusabora

2.2 Research Design
The design and development of the application in this study are based on the ADDIE model. The choice of this model is because the ADDIE model has systematic and easy-to-follow stages of creating a product [9]. According to Aldoobie (2015), this model is an approach that helps instructional designers, content developers of any kind, or even teachers to create efficient and effective teaching designs [10]. The ADDIE model consists of several phases: Analysis, Design, Development and Implementation and Evaluation. Concrete steps to develop android-based teaching material are described as follows:

1. At the analysis stage, both literature and field studies were conducted. Field study in the form of observation was carried out by identifying the students' and teachers' needs in the physics learning process. A literature study was carried out by analyzing the curriculum and finding references to solve the problems found.
2. Design stage is the stage to design a strategy for solving problems in the physics learning process. At this stage, the researchers designed an initial overview of Android-based teaching material by formulating the flow of material delivery in the form of flowchart, making storyboards, selecting applications, and preparing the tools and material used.
3. Development stage is the stage of creating the design of teaching material into an application. Once the product finished, it was validated by two expert lecturers who mastered the content of the topic chosen, to assess the feasibility of the product.
4. Implementation stage is the stage where the product that had been developed was tested on the assigned respondents and teachers. Then they were asked to provide responses using research instruments.
5. Evaluation stage is the assessment stage, which refers to the feasibility test results from validators, teachers, and students. At this stage, the feedback on the product was used as a guide for improving the quality of the product.

2.3 Data Collection Techniques
The study uses questionnaires to obtain the data. Questionnaire is one of the instruments containing a list of questions or statements to find out the respondents' opinions regarding a product or social
phenomenon [11]. The type of questionnaire in this study is a closed questionnaire because respondents were only given the option to fill in a checkmark in the alternative answer column. However, to give feedback on the product, the researchers provided a comment column at the end of the questionnaire. The questionnaire assessment uses a Likert scale measurement with four alternative answers ranging from the most positive to the most negative. In need of quantitative data processing, each answer choice from the statement is given a score. The obtained data is analyzed by calculating the average value of the overall score [12]. Data from the questionnaire was then converted qualitatively, as in Table 1 [13].

| Average Score | Criteria            |
|---------------|---------------------|
| 3.25 < X ≤ 4.00 | Very Good (VG)      |
| 2.50 < X ≤ 3.25 | Good (G)            |
| 1.75 < X ≤ 2.50 | Poor (P)            |
| 1.00 ≤ X ≤ 1.75 | Very Poor (VP)      |

The technique of analyzing student data is similar to that of experts and teachers, but what is different is the qualitative interpretation. Experts and teachers were asked to evaluate the quality of the product, by presenting the material and the overall appearance of teaching material. The students were asked for approval to evaluate whether the product developed could improve their understanding of the physics material or vice versa. Therefore, the mean score obtained from the quantitative analysis can be converted qualitatively by referring to Table 2.

| Average Score | Criteria        |
|---------------|-----------------|
| 3.25 < X ≤ 4.00 | Strongly Agree (SA) |
| 2.50 < X ≤ 3.25 | Agree (A)       |
| 1.75 < X ≤ 2.50 | Disagree (D)    |
| 1.00 ≤ X ≤ 1.75 | Strongly Disagree (SD) |

3. Results and Discussion
The analysis stages in the ADDIE model revealed that the teaching material used at SMAN 1 Sindue Tombusabora had not integrated ICT in the physics learning process. In fact, integrating ICT in learning can also improve student literacy in technology. The delivery of physics material, especially the material on temperature and heat, had been dominated by printed books in the form of textbooks or worksheets. The teaching method also still employed a teacher-centered approach. This means that the teacher tends to be the primary source of knowledge in the classroom rather than a facilitator who supports student learning activities. Thus, it reduces students' interest in learning physics. Moreover, for students, the physics subject is considered difficult, unattractive, unpleasant, and even scary for some students [14]. Therefore, researchers need to create Android-based teaching material on temperature and heat. In general, all students in SMAN 1 Sindue Tombusabora already have smartphones. This fact has become a reference for researchers to create android-based teaching material that can be accessed via smartphones to increase student motivation to learn. The material that will be integrated into the teaching material is temperature and heat. According to the 2013 curriculum, the material was discussed in class XI.

Based on the analysis results above, android-based teaching material was developed at the design and development stage. At the design stage, the outline of the material, instructional objectives according to the syllabus and the software used had been set. The researchers also designed the appearance of the application, including the selection of visual colors and figures. Then at the development stage, the product was developed. Android-based teaching material was composed using Game Maker Studio v1.4 software. Even though the name is Game Maker, it can be used to create
applications other than games and the manufacturing process without complicated scripts. The researchers collected all materials from literature review, both from books and other references, then inserted them into the software. The results of android-based teaching material can be seen in Figure 1.

![Figure 1](image_url)

**Figure 1.** Display menu for Android-based teaching material

Figure 1.a is the initial display when the user opens the application for the first time. Students will be presented with a home menu with features such as instructions for use, learning material, questions, bibliography, and about me. Students can pick the user manual icon to learn the instructions for using the application. Furthermore, the temperature and heat material can be accessed by pressing the learning material button and will enter the display as shown in Figure 1.b. The menu of questions serves to evaluate students' understanding of the material accompanied by discussion. The table of contents menu contains a collection of references from the subjects in the teaching material, while the about me feature describes the application makers. Before being implemented to respondents, the product requires a feasibility test by experts. Questionnaires were given to two lecturers whose assessment results are shown in Table 3.

| No | Assessment Aspects                                      | Score | Category   |
|----|--------------------------------------------------------|-------|------------|
| 1  | Material Feasibility Aspect                            | 3.25  | Very Good  |
| 2  | Feasibility of the Effect of Teaching Material          | 3.40  | Very Good  |
| 3  | Presentation Feasibility                               | 4.00  | Very Good  |
| 4  | Media                                                  | 4.00  | Very Good  |
|    | **Total**                                              | **3.66** | **Very Good** |

As Table 3 shows, the experts gave a total score of 3.66, categorized as "very good." In fact, there were two aspects of the assessment that had a perfect score, the media aspect, and presentation feasibility. When referring to the statements in the questionnaire, the assessment indicators for these two aspects were about the flow of material that could be easily understood and the design to motivate students to learn using Android-based teaching material. Yet, there were some additional notes for researchers for improving the teaching material. The respondents suggested that researchers should add the explanation of the expansion of liquids and gases and add the example of heat transfer in everyday life. Based on these suggestions, the researchers made improvements according to the
suggestions given. The improved Android-based teaching material was then tested on teachers and students. Tests on teachers and students were included in the implementation phase of the ADDIE model. Similar to the assessment carried out by experts, teachers were also asked to provide an assessment. However, the list of statements in the questionnaire was different. The results of the teacher's product feasibility test assessment are depicted in Table 4.

**Table 4. The results of the product feasibility assessment by the teachers**

| No | Indicator                  | Score | Classification |
|----|----------------------------|-------|----------------|
| 1  | Curriculum                 | 3.00  | Good           |
| 2  | Contents                   | 3.50  | Very Good      |
| 3  | Product Feasibility        | 4.00  | Very Good      |
|    | Evaluation                 |       |                |
| 4  | Languages                  | 3.33  | Very Good      |
|    | Average                    | 3.45  | Very Good      |

The average score from the above assessment results shows a score of 3.45. If converted according to the Likert scale measurement, this product is considered very good and suitable for the physics learning process, especially on temperature and heat subject. This is also supported by the absence of additional suggestions or criticisms in the questionnaire comments column. Therefore, the feasibility test continued giving questionnaires to 20 students as respondents. The questionnaire for students has 13 positive statement items. Each statement item from each respondent was analyzed to get an average score. The final score is 3.50, which is categorized as strongly agree. More clear explanation can be seen in Table 5.

**Table 5. The assessment result of student responses to the product**

| No | Statement                                                                 | Score |
|----|---------------------------------------------------------------------------|-------|
| 1  | I get excited and motivated to learn physics with the presence of android-based teaching material | 3.90  |
| 2  | I can study independently with teaching material                           | 3.30  |
| 3  | I can learn according to my speed and intensity of learning               | 3.15  |
| 4  | I prefer to learn with android-based teaching material rather than listening to the teacher's explanation in class | 2.95  |
| 5  | Through android-based teaching material I can understand the material      | 3.30  |
| 6  | I think this teaching material can help the teacher to explain the material| 3.65  |
| 7  | In my opinion, using this application makes physics subjects not boring   | 3.65  |
| 8  | Sample questions and pictures in the application of teaching material help me understand well about temperature and heat | 3.65  |
| 9  | I like the design of android-based teaching material because it has a match and attractive color and image composition | 3.50  |
| 10 | Instructions for using android-based teaching material make it easier for me to use the application | 3.40  |
| 11 | Android-based teaching material motivates me to learn physics              | 3.65  |
| 12 | I think this teaching material can make physics learning flexible because it can be studied anywhere and anytime | 3.70  |
| 13 | I think the writing in the application is clear and easy to read           | 3.75  |
|    | **Average Total Score**                                                   | **3.50** |

Table 5 shows the positive responses of students when using teaching material. It can be seen from the score for the statement item about students' motivation to give the highest score of 3.9 which means that this android-based teaching material can motivate students to learn physics. In addition, several statement items about the role of teaching material in improving students' understanding of temperature and heat material also scored in the category of strongly agree. However, on the other hand, there was an average score of 2.95, categorized as agree. This shows that students also still need...
the teacher's role in the physics learning process because the teaching material in the learning process only act as a supporting learning resource for teachers in the classroom. Then the final stage of the product being developed is the evaluation stage. According to Murdiono et al. [15], this stage was a phase to see if the success of teaching material can be useful for students or vice versa. The measure of the product's usefulness can be seen from the overall analysis of the questionnaire given to experts, teachers, and students. Overall, it can be said that these teaching materials are suitable for use in learning physics.

Several studies on the development of android-based teaching material had also been carried out by other researchers, but there are differences including: (1) the topics discussed in the teaching material were different. (2) Applications that have been developed require more than one application such as Adobe flash CS6, CorelDrawX7, Adoobe Air 3.5 and macromedia flash. (3) Practice questions in limited applications [16,17].

This development of Android-based teaching material has several advantages: (1) Teaching material in this Android application can be used by students on any smartphone without an internet connection or accessed offline. (2) There is a review of the discussion of practice questions. Reviews of discussion questions are useful to help students understand the flow of answers to practice questions. (3) The capacity of this application is relatively low, which is only 27.64 MB. Thus, the app installation will not occupy the storage of the device. However, the drawback is that the physics formulas in the application must be converted to image format (JPG) first.

4. Conclusion

The design and development of the application in this study have produced an android-based teaching material product. The development steps are based on the ADDIE model, consisting of 5 stages: analysis, design, development, implementation, and evaluation. Based on the feasibility test of the expert teachers, the students gave a score of 3.66, 3.45, and 3.50, respectively. The assessment results showed that this teaching material can be used as one of the teaching material to increase students' interest and motivation to learn physics. Because the dissemination of this product is still on a small scale, in the future, this product can be tested for effectiveness in a broader scale.

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