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Developing The Android-Assisted Physics Interactive Learning Media to Reduce Senior High School Students' Misconception About Physics and Improve Their Attitude Towards It

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Abstract. The objective of the research concerned here was (1) to develop and produce the Android-assisted physics interactive learning (PHIL) media for senior high school students; (2) to reveal the appropriateness of the developed Android-assisted PHIL media; and (3) to reduce senior high school students' misconception about physics and improve their attitude towards physics (ATP) by using the Android-assisted PHIL media. The research was research and development (R&D) in type with the product development procedure adapted from the Borg & Gall development model and the steps being that of information collection and those respectively of product planning, development, validation, evaluation, and dissemination. The research results are as follows: (1) the developed software of the Android-assisted PHIL media could be used in physics learning with the temperature and heat theme both in and out of the classroom and contains subject matter explanations, simulated examples, and varied, interesting, and interactive exercises, (2) the developed media is deemed appropriate for use and of very good quality according to evaluation by experts of physics material and of media, peer reviewers, and physics teachers and meets the criteria for good quality according to evaluation in a tryout by the students, and (3) MANOVA results indicate that there is difference showing reduction of misconception about physics with a gain of 0.49 and improvement in ATP with a gain of 0.38 in the students taught by using the Android-assisted PHIL media with the said gain being medium in level.

INTRODUCTION

Learning activities at educational units are conducted in interactive, inspirational, and pleasing manners, challenging and motivating the students [15]. However, in reality the learning process is still dominated by the teacher teaching without paying attention to whether the students are really involved in the learning. In a class of physics, for example, attention needs to be paid to the characteristics of the material and the students in the learning process in order not to give the impression that physics is complicated, feared [22], and boring [19] so that it is disliked [8]. It is found that in the science learning process there are occurrences of the teacher not inviting the students to discover the concepts [21], putting emphasis on information memorization and recall only [12] in spite of learner attitude being one of the factors influencing learning quality [3]. Learners' real involvement in the learning activity is quite influential in improving learners' attitude towards and view about science [29]. Research reveals that a positive attitude towards a science lesson could improve academic achievement [16,29].

In a teaching and learning process there is a process of concept change. An initial concept that is not in line with a scientific concept [1] or a concept acknowledged by experts [25] is what is called a misconception. A factor causing a misconception of physics could come from more than one possible source, namely, the lesson book [7], the student,

the teacher, the context, and the manner of teaching [25]. A misconception occurring in the physics field of study is related to, among others, material about temperature and heat. A misconception of the physics material concerning temperature and heat occurs when a part of the students equate the concepts of temperature and heat with hot and cold occurrences or when students could not yet understand the concepts of thermal balance, specific heat, and heat capacity [4,2]. Such misconceptions could be caused by the teacher having difficulty in determining the way to deliver a concept which is abstract in nature in relation with substance particles and its connection with heat and the movement and change of particle compositions [18], an error in strategy, translation, concept, calculation, or sign [20], not to mention how difficult it is to conduct an observation on physical phenomena happening quickly [9]. How difficult it is to benefit from the laboratories at school because of various constraints also becomes a constraint in the learning process at school [26].

Science and technology are developing very rapidly in the current era of globalization. In particularly the field of education, technology has a share in becoming a part of the developments for the attainment of educational objectives both nationally and internationally. Nihalani, Mayrath, & Robinson reveal that the utilization of multimedia as learning media influences the learning process [17]. It is also revealed in some other research that the integration of technology into learning enables learners to interact with learning sources and trace information and data and facilitates the occurrence of inter-learner communication, discussion, collaboration, and so on and, additionally, the availability of technological and informational products could accelerate the learning process in class [11]. Technology makes it possible to change the way of facilitating how the learning process is in progress thus urging learners to the direction of becoming active ones [13]. From some research results, it is found that media could improve learners' motivation [23] and interest and achievement in learning physics [6,5]. The effect of media simulation could improve students' absorption power and learning consentration [10] and ease students' comprehension and understanding of the material being studied [28]. Media development done with Android assistance enables learners to access the material and application related to the lesson without being restricted by space and time wherever and whenever they wish to do it [14] Moreover, the development of Android use in Indonesia within the last two years' period (namely, from June 2013 to June 2015) has now reached 65.9% [24] With the exposition above as basis, an Android-assisted physics interactive learning (PHIL) media has been developed to reduce SMA (*sekolah menengah atas* 'Indonesian senior high school') students' misconception about physics and improve their attitude towards physics (ATP) in relation with the material about temperature and heat.

METHODS

Types, Places, and Research Subjects

The research method used was R&D (research and development). This method is used for the purpose of resulting with a certain product and testing the effectiveness of a product. The main field testing was designed as implementation of the resulting product in quasi-experimental research. The selection of the subjects was done by means of group random sampling. The main field testing was done by involving students of Grade X (the official term in the national educational system for the first grade of SMA) at SMAN (*Sekolah Menengah Atas Negeri* 'State Senior High School') 3 Yogyakarta.

Table 1. Subjects in the field Testing.

Product Testing		Number of Students
Initial Field Testing	individual tryout (in one-to-one evaluation)	10
	small-group tryout (in small-group evaluation)	20
Main Field Testing	experimental-class tryout with The PHIL media	31
	control-class tryout	32

Procedure of Development

The procedure of the development was an adaptation of the Borg & Gall research and development procedure. It was divided into the stages of 1) information gathering (oriented to needs analysis); 2) product planning; 3) product development; 4) product evaluation; and 5) product dissemination. The information gathering was done by identifying and getting data. This stage consisted of literature study or theoretical review, field survey, and needs analysis related to the possible media development that would be done to solve learning problems encountered in the research. The product planning stage was for finding a way to develop the product and the media-using learning design (core competence, basic competence, the theme or subject matter to learn, and the indicators). The PHIL media development consisted of several steps, the first of which was that of making the media design. The following step was of collecting the learning material and references. In the next step, the learning media was made by using the computer and support from Adobe Cs 6 with Action Script 3. The first step in the evaluation of the PHIL media product was of product validation. The validation of the product resulting from the development stage was done by lecturers (namely, university teachers) who were respectively media and learning material experts, physics teachers, and university students of physics education as peer reviewers. After the validation was done, the product was revised and initial field testing was held. The product was again revised and then the main field testing was done by students. In the stage of dissemination, a report of the final field testing product was published as school research and as research journal article.

Instruments and Data Collection Technique

The research data were collected by using test and non-test means. The non-test means involved questionnaire use and observation, documentation, and interview making. The questionnaires used were for the evaluation of respectively the media and ATP. To obtain data of reduction in students' misconception, a test instrument in the form of a misconception test was used. The construction of the indicators in the research was based on research on and or tests of attitude that had previously been conducted (namely, TOSRA, CLASS, ROSE, etc.) and to which the researcher had applied adjustments and or adaptations. The instrument developed for obtaining data of ATP was in the form of a questionnaire with each item in statement form to be responded to by involving a Likert scale.

Table 2. Grid of Items to Obtain ATP Data

Aspect	Indicator	Form of Instrument
Attitude Towards Physics	Attraction to Physics	Questionnaire
	Physics Learning Process	
	Importance of Physics	
	Learning Media (Tool)	

The test instrument to get misconception data was an objective test consisting of multiple-choice items with open reason and the test was about physics material concerning temperature and heat. The determination of the students having misconception was by using CRI (Certainty of Response Index) (0-5) adapted from Tayubi [27], whose research indicates that the method used is sufficiently effective in being able to differ students having misconception from those not understanding concepts. In addition, with good planning of the research instrument, alternative conceptions that were misconceptions in the students' part could also be identified. A grid contained indicators serving as references in writing the instrument. The misconception items used resulted from analysis of journal and book contents and results of field studies done in the research and development undertaking. The test and non-test given at pretest and posttest time had already been validated by experts and had also been empirically validated. Validation categorization and the obtained qualitative data were converted into quantitative ones with the criteria for Giving ATP Scores [30].

Table 3. Criteria for Giving ATP Scores (Likert scale)

No.	Category	Score
1.	Very Much Disagree	1
2.	Disagree	2
3.	Agree	3
4.	Very Much agree	4

The misconception reduction and Improvement in students' ATP were determined from the normalized mean gain score. The interpretation based on gain score refers to the gain score (g) criteria.

Table 4. Gain Score Category

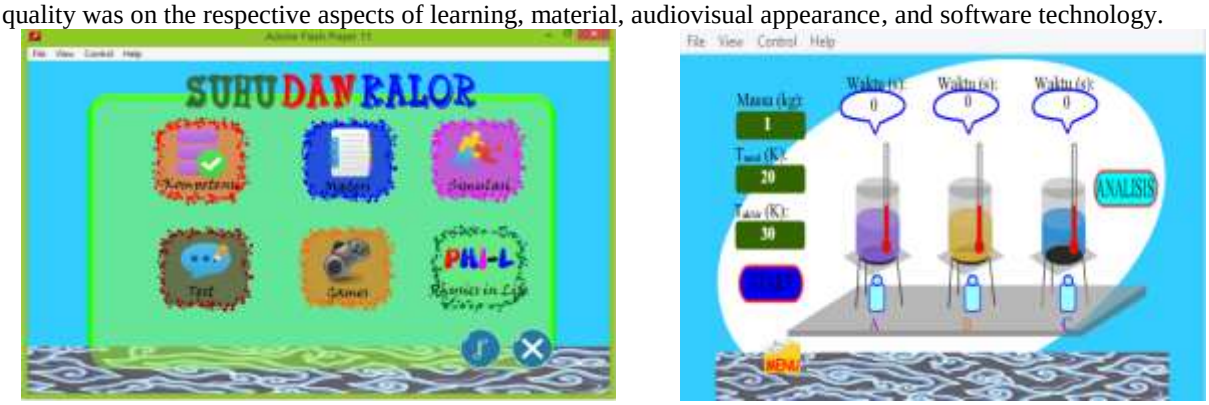
Interval	Category
$(g) \geq 0.7$	High
$0.7 > (g) \geq 0.3$	Medium
$(g) < 0.3$	Low

The significance of difference in misconception reduction and improvement of ATP between the experimental class and the control class was determined by seeing the result of statistic testing by means of multivariate analysis (MANOVA) because there were two dependent variables. The statistic hypothesis tested in the research (the conclusion) was obtained by interpreting the value of significance obtained from the MANOVA through SPSS 20.

RESULTS AND DISCUSSION

Product: The PHIL Media

The resulting SMA-level physics learning media product was in the form of an Android application (which could be in a smartphone, tablet, or notebook). The program output was a file with the *apk* extension, which was the file required for application installation in Android. The PHIL media consists of six main menus. Simulation menu contains simple simulation and analysis for an experiment with heat and specific mass. Competence menu contains information of the basic competence and learning indicator becoming the references in the learning media development. Material menu contains an exposition of material concerning temperature and heat concisely presented, pictures, and videos supporting the explanation of the material. exercise menu contains exercise items formatted in the form of objective-type question items with the solution. Game menu contains a game in the form of a quiz presenting a question with a true or false answer. Physics in life menu contains pictures and information of examples related to material about temperature and heat whose application is found in daily life. The evaluation of the media quality was on the respective aspects of learning, material, audiovisual appearance, and software technology.

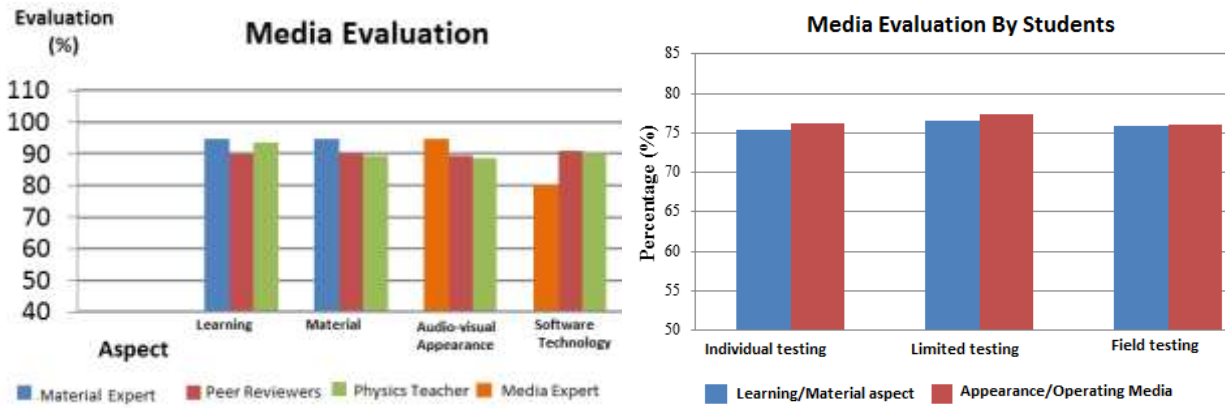


(a) (b)

Figure 1. Appearance of the PHIL Media (a) menus, (b) "simulation menu".

The results of evaluation by the material expert, media expert, peer reviewers, and physics teachers on the four aspects were within the 88.7%-94.5% range, indicating those aspects being Very Good in quality except for the software technology aspect, as evaluated by the media expert, but on the average the quality of the four aspects was judged Very Good category. The media quality evaluation by students also indicated that the media was appropriate

to be applied on learning because of two aspects of evaluation being within the 75.4%-77.4% range. The scores indicated that the product was Good in quality category.



(a) (b)

Figure 2. (a) Media Evaluation (b) Media Evaluation by Student

Misconception Reduction and Students' ATP

Misconception reduction was seen from the difference in the misconception occurring according to pretest and posttest results. The mean gain score obtained for the experimental class was -0.49, with the negative sign indicating a decrease, meaning that the media use was influential on students' misconception reduction being medium in category.

Table 5. Misconception Reduction and Students' ATP Results

Class	Misconception Mean Score		Mean Gain Score	Mean Score for ATP		Mean Gain Score
	Pretest	Posttests		Pretest	Posttests	
Control	9.63	5.50	-0.24	85.528	96.733	0.260
Experimental	11.81	4.13	-0.49	85.562	102.075	0.380

The mean gain score showing improvement in students' ATP in the experimental class was 0.380, indicating that the influence of using the learning media developed on the improvement of the students' ATP was also medium in category.

Table 6. Results of MANOVA

Effect	Sig.	Criteria for Decision	Decision
Hotelling's Trace	0.000	Sig < 0.050	Ho rejected

The decision hoped for in the research was to reject Ho and accept Ha. From the results of the MANOVA, it is seen that the value of significance obtained was smaller than 0.050 (Ho rejected) so that it could be concluded that there was difference, in reduction of students' misconception and improvement of students' ATP, between the experimental class using the Android-assisted learning media and the control class not using it.

The execution of the research and development concerned here had several limitations. The Android software supporting the use of the learning media developed is not possessed by all students. The quality of the learning media appearance is greatly determined by the type of Android software used. The use of smartphone-based learning media at school being allowed depends very much on school discretion.

CONCLUSION

With the results of the research and development done as basis it could be concluded that The Android-assisted media that has been developed for interactive physics learning (PHIL) of the material about temperature and heat could reduce students' misconception about physics and improve their attitude towards physics

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