Developing android-based science instructional media to improve scientific literacy of junior high school students

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Abstract. The aims of this study are: to develop android-based science instructional media and to reveal the characteristic, the quality, and the effectiveness of android-based science instructional media with global warming topic to increase junior high school students’ scientific literacy. This study is a development research. The instructional media were reviewed by a media expert, a material expert, science teachers, peer reviewers, and students. The data was collected using media evaluation questionnaires. The results of the study showed that: (1) the android-based science instructional media has characteristics including interesting visualization, easy to use, flexible, and practical, (2) the android-based science instructional media was appropriate for teaching, in terms of material evaluation aspects, media evaluation aspects, and based on student test results, and (3) the android-based science instructional media can effectively used for teaching.

1. Introduction
Scientific methods include observation and experimentation. Scientific attitude consists of curiosity, open, and honest. According to scientific learning is not only to master a certain amount of knowledge as a science product, but also to provide sufficient space for the development of scientific attitudes, practice problem-solving, and real-life science.

Science learning activities develop the ability to ask questions, seek answers, understand answers, and refine answers about “what”, “why”, and how about natural phenomena and natural characteristics around them through systematic ways to be applied in the environment and technology. Science learning is a learning about nature and surroundings which is studied systematically using concepts, facts, and principles. Science learning can be applied and developed in everyday life using attitudes and scientific values such as experimental process and the discovery and its application to the environment and technology. The whole process of education in school and learning activities is the most important activity. This means that the success or failure of the achievement of educational goals depends on how the learning process itself.

Learning media can help to clarify information being conveyed for minimizing verbal communication, especially for passive students. If a learning media is appropriate and varied, the
limitations of space, time, and power can be overcome [1]. Heinich, argues that "technology or learning media as a scientific application of the learning process in humans is the practical task of teaching and learning".

Mobile-learning or M-Learning is a type of learning that provides educational content and material supports using wireless communication tools. A mobile learning tool is designed to connect and function interactively with a computer used in the classroom, in collaborative learning during work environments, and during guidance and counseling. Li mentioned that the implementation of learning using smartphones and tablets can provide positive impact on students’ cognitive, metacognitive, affective, and sociocultural dimensions. Smartphones and tablets have the power to transform learning experiences. This type of learning media allows learners to learn information without any restriction in time and place using interesting applications [2].

The use of Android-based learning media is one application of the 21st century learning style [3]. Android learning is a method or technique used in teaching and learning activities with the intention that the interaction between teachers and students can be made effectively during the learning process, anywhere and anytime. To overcome the limitations of space and time, Android operating system applications using Internet network are applied.

Scientific literacy is one of several types of literacy such as written literacy, numerical literacy, and digital literacy. In scientific literacy, students are invited to overcome their fear in science learning. Students will be able to understand experimental methods and scientific reasoning during the science learning [4]. Meanwhile, American Association for the Advancement of Science [5] stated that "science literacy is the ability to follow scientific discourse and to connect the world of science to the context of everyday life - the ability to make science personally relevant".

Scientific literacy means knowledge or understanding of concepts in science learning and processes related to personal decision making, participating in public interest, cultural affairs, and economic productivity [6]. The scientific literacy is to examine and explore the concept of science literacy of junior high school students who in this context are categorized as early adolescents. The term adolescent literacy refers to the ability of adolescents to make concepts of science learning more meaningful both inside and outside school. Learning is conducted to try to illustrate how to change the point of view of specific literacy contents in science learning. The learning uses learning resources in the form of books with the addition of other learning resources provided by the teacher.

Hazel and Trefil [7] stated that "scientific literacy constitutes the knowledge you need to understand the public issue. It is a mix of fact, vocabulary, concept, history, and philosophy". Similarly, the Program for International Student Assessment (PISA) [8] explained that the main quality of science literacy is the ability to apply scientific understanding into everyday life by incorporating science. In addition, science literacy includes knowledge of science, fundamental understanding of the science concepts, comprehension of inquiry, and explanation of natural science [9].

ByCee recommended four levels of scientific literacy. The first level is nominal scientific literacy which is for students who are able to relate concepts to science but their conceptual understanding is still low which is indicated by misconceptions. The second level is functional scientific literacy which is for students who are able to describe science concept correctly, but they have limited understanding of the concepts. The third level, conceptual scientific literacy, is for students who are able to develop basic concepts of learning materials and able to correlate basic understanding of science in the process of science inquiry and technology design. The last level is multidimensional scientific literacy that describes students’ ability to understand science, science concepts, and procedures of scientific investigation, including philosophy, history, and awards in science and technology in everyday life [10].

Scientific literacy is the knowledge needed by students to understand the scientific concepts, natural phenomena, and public issues in daily life in order to find, connect, respond, and provide questions related to the science concept, get answers and facts on what really happened, be able to apply scientific understanding into everyday life by incorporating science, as well as to build the basic concepts of learning materials and able to correlate the basic understanding of science in the process of science inquiry and technology design.
Based on the aforementioned facts, this study was designed to develop android-based science learning media and to understand the characteristics, quality, and effectiveness of android-based learning media with the topic of global warming to improve students’ scientific literacy.

2. Research method

2.1. Place and time of research
This research involved Grade VII of Junior High School students in Yogyakarta City, Indonesia where Curriculum 2013 has been implemented. The research was conducted in semester 2 (even) of the academic year 2016/2017.

2.2. Research participants
The research participants consist of a panel experts in media and students. The panel expert includes one expert in teaching content and one expert in media, 5 peer reviewers, and 2 science educators. 30 junior high school students of grade VII were involved in the pilot study of the learning media. More students were invited in the main study comprising 32 students in the experimental class and 31 students in the control class to test the learning media.

2.3. Research procedures
The research was conducted by adopting the ADDIE development model developed, including Analysis, Design, Development, Implementation and Evaluation. The research stages that have been done in this study includes the stage of analysis (objective analysis, curriculum and material analysis, ability level analysis and user target characteristics), design (design of items to be presented, preparation of the material, the flow of material delivery flowchart, making of storyboard media, and the collection of materials needed in media development), development (implementation of media using two software items Construct 2 and Quick App), implementation (assessment by media experts, material experts, and field practitioners as well as the implementation of limited trials), and evaluation (assessment of media developed, carried out during the previous four stages).

2.4. Techniques and data collection instruments
The data in this research were collected using media assessment forms and test instruments. The media assessment forms consist of (1) media assessment sheets for instructional media experts, (2) material assessment sheets for material experts, and (3) media quality assessment sheets for peer reviewers and science educators. The test instruments consist of (1) learning media quality sheets of learners (used in the pilot study), (2) motivational learning questionnaires (used in the main study), and (3) cognitive learning test sheets (used in the main study). Instruments for media quality assessment were developed by adapting the instruments.

The research instrument used in this study was the test used meaning that the instruments were implemented directly to the sample to obtain research data. Based on the research data, then the validity and reliability of the test instruments were tested. To test the construct validity of the instruments, the experts’ opinions (judgment experts) were reviewed. The instruments were constructed using aspects that will be measured by a particular theory, then further consulted with experts. The experts were then asked to give comments on the instruments that have been prepared.

To determine the level of validity of the learning media developed in this research, the criteria of assessment qualification based on Table 1, were used.

| Percentage (%) | Validation Level | Explanation             |
|---------------|------------------|-------------------------|
| 76-100        | Valid            | Feasible / no need revision |
| 50-75         | Quite valid      | Quite feasible / partial revision |
| 26-50         | Less valid       | Less feasible / partial revision |
| <26           | Not valid        | Not feasible / total revision |
To determine the level of practicality of developed learning media, will use the criteria for qualification assessment based on Table 2.

| Percentage (%) | Practical Level | Explanation                        |
|----------------|----------------|-------------------------------------|
| 76-100         | Practical      | Feasible / no need revision         |
| 50-75          | Quite practical| Quite feasible / partial revision   |
| 26-50          | Less practical | Less feasible / partial revision    |
| <26            | Not practical  | Not feasible / total revision       |

The scientific literacy data were collected from the test of students' learning outcomes before and after the learning process. The data obtained was determined by N-Gain value. The gain value was obtained using N-Gain [11].

\[ NG = \frac{p \cdot t \cdot s}{m} - \frac{p \cdot s}{s} \]

The normalized low gain (N-Gain) can be classified as follows: (1) if \( g \geq 0.7 \), then the result of N-Gain is a high category; (2) if \( 0.7 > g \geq 0.3 \), then the result of N-Gain is of medium category, and (3) if \( g < 0.3 \) then the result of N-Gain is low category.

3. Results and discussion

The product of the development research is an Android application in the form of learning media of Global warming for science learning. It can be operated on Android devices. The minimum requirements to run this application on an Android device are, as follows:

- ARMv7 processor with vector FPU, minimum 550MHz, OpenGL ES 2.0,
- H.264 and AAC HW decoders.
- Minimum Android 2.2 (Froyo)
- RAM 256MB

Broadly speaking, the menus contained in the learning media include (1) Basic Competence, (2) Materials, (3) Activity 1, (4) Activity 2, (5) Activity 3, and (6) Evaluation.

In the first page or so called cover page, there is a start button and credit (see Figure 1). The start button functions to start learning or to enter the main menu of learning media. Then the credit button will lead you to credit and references used to create the media.

![Figure 1. Cover page of the learning media.](image)

Menu page (see Figure 2) is a list of contents in the learning media. The functions of the buttons in the menu are as follows:

- Back button is back to the cover page
- The Menu button is the menu itself
- Button 3 is to the basic competence page
• Button 4 is towards global warming learning materials
• Button 5 is towards the evaluation of learning
• Button 6 is to the 1st learning activity
• Button 7 is to the 2nd learning activity
• Button 8 is to the 3rd learning activity

![Menu page of the learning media.](image1)

Figure 2. Menu page of the learning media.

Basic competency page (see Figure 3) contains learning basic competencies that need to be achieved. The function of next button in this page is to proceed to the next page that is still associated with the competency. The function of the menu button is to return to the main menu of learning media.

![Basic competency page of the learning media.](image2)

Figure 3. Basic competency page of the learning media.

Material page contains summaries and additional materials that students can use to help complete the learning activities about global warming. The function of next button in this page (see Figure 4) is to proceed to the next page that is still related to learning materials, while the function of menu button to return to the main menu of learning media.

![Material page of the learning media.](image3)

Figure 4. Material page of the learning media.
Activity page 1 is divided into 3 parts (see Figure 5).

- Part 1 contains instructional videos and student worksheets. In the first section of the activity page there is a learning video, a play button to run a learning video, a pause button to stop learning videos, and a next button functions as a key to Part 2.

![Figure 5. Activity page of learning media.](image)

- Part 2 contains the back button to go to part 1 containing learning videos, LKPD 1 button works towards learning online on google drive. Then the menu button that functions to go back to main menu of learning media.

  If you press the LKPD 1 button then the option menu will show (see Figure 6). The user can decide to continue to open LKPD 1 using the browser, either the default browser of the Android device or browser that has been downloaded from the play store. The designer recommends to open the LKPD 1 using Google Chrome to make it more convenient, although it can also be opened with other apps.

![Figure 6. The option menu in the LKPD 1](image)

Section 3 is part of the LKPD 1 which will appear if LKPD 1 button is pressed (see Figure 7). LKPD 1 contains:

- The personal information of group members
- Password, the function of password here is to maintain the confidentiality of LKPD to be accessed simultaneously in order to avoid individual work, because LKPD 1 is required to be done with the group.
- The goals of learning
- Questions or questions relating to learning videos in Part 1 activity.
- The red asterisk functions to prevent so that the answer cannot be empty, or to avoid answers being submitted before all the questions complete.
In evaluation page (see Figure 8), there are menu buttons and 30 items of multiple choice questions. The question can only be opened and done with internet connection because the system is online and using google drive. The evaluation of the evaluation page in google drives is as follows:

4. Product Validation
The product validation is performed by a material expert, a media expert, and two science teachers. Test the validity of the constants from media experts and material experts for android-based learning media. The validation of the product is carried out using a media evaluation instrument that has been validated by the validator of the research instrument.

| Table 3. Values of learning device validation |
|-----------------------------------------------|
| Validation on product | Expert | Science Teacher |
|------------------------|--------|-----------------|
| Syllabus               | 3,91   | 3,73            |
| Lesson plan            | 3,83   | 3,71            |
| Student worksheet      | 3,71   | 3,79            |

The results of validation by experts and teachers of science showed an average value above 3.5 which means that the tools that have been developed have good categories and can be used in the learning process.
Table 4. The value of media experts from the android in-app display:

| Criteria Validation       | Expert | Science Teacher |
|---------------------------|--------|-----------------|
| Language                  | 4.75   | 4.75            |
| Multimedia view           | 4.5    | 4.67            |
| Easy to use (navigation)  | 4.5    | 4.5             |

Validation results by media experts related to android media display shows an average value above 3.5 which means that the device that has been developed has a good category and can be used in the learning process.

Instrument reliability values for science learning devices were taken from the approval of two experts and two science teachers who were analyzed quantitatively using percentage agreement described in table 5:

Table 5. The percentage agreement value of the learning tools developed.

| Validation product | Percentage Agreement Expert | Percentage Agreement Science Teacher |
|--------------------|-----------------------------|--------------------------------------|
| Syllabus           | 98.84                       | 98.81                                |
| Lesson plans       | 97.83                       | 97.93                                |
| Student worksheet  | 98.02                       | 98.08                                |
| Media              | 91.60                       | 92.80                                |
| Average            | 96.57                       | 96.90                                |

The instrument reliability value of 30 question items is 0.92 in the reliability of item estimate and 0.70 in the reliability case estimate based on the analysis of the analysis with the Quest program. From 30 items tested, 28 items in the question has INFIT MNSQ value in the range of 0.77 to 1.30 so it can be concluded that the pesky item is declared valid or FIT with the model in Quest.

Table 6. Description of scientific literacy data on the research sample.

| Description    | Kelas Eksperimen | Kelas Kontrol |
|----------------|------------------|---------------|
|                | Pretest | Posttest | N-gain | Pretest | Posttest | N-gain |
| Average        | 64.15   | 75.67    | 0.29   | 63.15   | 70.03    | 0.17   |
| Standart Deviasi| 10.57   | 10.47    | 0.31   | 11.11   | 11.81    | 0.27   |
| Varians        | 109.60  | 108.70   | 0.09   | 125.79  | 135.55   | 0.78   |
| Maximum        | 76.59   | 89.93    | 0.79   | 79.82   | 89.01    | 0.65   |
| Minimum        | 36.63   | 43.29    | -0.70  | 36.63   | 39.96    | -0.40  |

According to the table X comparison of average pretest of experiment class 64.15 and control class 63.15. The average values of the experimental class posttest is 75.67 and the control class is 70.03. The average comparison of N-gain was 0.29 for the experimental class and 0.29 for the control class.

5. Conclucion
The results of the study show that the android-based science instructional media has characteristic such as interesting visualization, easy to use, flexible, and practical, the developed android-based science instructional media is appropriate for teaching, in terms of material evaluation aspect, media evaluation aspect, and based on the results of students’ tryout, and the effectiveness of the product to improve scientific literacy. The result showed that the android-based science instructional media was appropriately and effectively used for teaching.
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