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Developing an android-based application (AVALIMA) for chemical literacy evaluation

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Abstract. The aim of this research is to determine the feasibility and perceptions of teachers and students about AVALIMA, a based on android application, as a chemical literacy evaluation media. AVALIMA was developed by taking the first stage of 4D model, that is define, design, and develop without disseminate. The initial product of AVALIMA was reviewers by material expert, media expert, and peer reviewers. Furthermore, AVALIMA was also assessed by five chemistry teachers by regarding to six aspects, namely material, science literacy, construction, language, visual appearance, and program performance. AVALIMA was also tried out to ten students in the eleventh grade. The result of the analysis shows that AVALIMA is a good android-based media that can be used to evaluate chemical literacy. According to the reviewers, the application is 88.2% appropriate to be used to evaluate chemical literacy. Meanwhile, according to the students’ response in using this media, it is 86.31% appropriate to be used as media to evaluate their chemical literacy. The teacher’s and the students’ perception toward the application is also very good.

1. Introduction
The influence of technological development in many aspects has grown rapidly these days, including education. The use of information and communications technology (ICT) in education can be found in the form of the media used, for example audio-visuals, computers, laptops, smartphones, and others. Compared to all the technology devices mentioned, smartphone always seems to outshine the others. It is merely because it has more capabilities in resolution, features, and computing, including the operating system [1]. One of operating systems on smartphone is Android. Android is a Linux operating system for smartphone which is free and uses open source code that offers rapid processing and innovative features [2]. Based on the research of Stat Counter [3], the use of Android as a developing operating system in Indonesia has grown up to 67% and is now dominating the smartphone market. Many consumers choose to use Android as an operating system because it is easier to use and provides access to install multiple applications as desired for free. The operation of the Android system on smartphone is also easy. Hence, it is also popularly used as a learning media.

In accordance with the development of ICT, teachers are expected to be able to develop a technology-based learning media as an innovation. Learning media is a tool to convey message information and as everything that can affect student learning [4]. One of the learning media innovations is technology-based practice questions that can be used by students to evaluate or measure learning outcomes.

Learning evaluation was defined as a process to evaluate activities or correct things that have happened or been implemented during the learning that has taken place [5]. To obtain good evaluation
results, evaluation activities must have the principles of (a) continuity, (b) comprehensive, (c) fair and objective, (d) cooperative, and (e) practical. According to Sukardi [5] the principles of evaluation (a) the evaluation must still be in the working lattice of the intended purpose; (b) evaluation should be carried out comprehensively; (c) evaluations are held in a cooperative process between the teacher and students; (d) valuations are carried out in a continuous process; (e) evaluation must be concerned and consider the values that apply.

The common evaluation in teaching and learning through ICT based learning is objective test. There are many advantages in developing of this type of evaluation [6], i.e. (a) multiple choice tests have flexible properties to measure student learning outcomes; (b) test items that are intensively constructed can cover all learning materials; (c) multiple choice test items can measure students’ knowledge, attitudes and skills; (d) students’ answers can be corrected easily by using answer keys that have been prepared separately; (e) the results of student answers can be corrected together with a more conducive situation.

The outcomes of students’ learning in chemistry subject are considered to be not yet satisfying. There are many students who still experience some difficulties in studying chemistry subject at school [7]. They view chemistry as a difficult, complex and abstract subject that requires special intellectual talent and a strong effort to understand it [8]. Students’ difficulties in understanding the concept of chemistry, or science in general, are revealed in the 2015 PISA (Program for International Student Assessment) results. In the field of science, Indonesian students are in the rank of 64 out of 70 surveyed countries [9]. PISA tests are usually in the form of open questions based on real life contexts. Students are required to use their abilities to understand and interpret the problem. This kind of process is a part of chemical literacy.

Shwartz, Ben-Zvi, & Hofstein [10] define chemical literacy in four domains: content, context, skills, and affective. Chemical literacy in the content domain of chemistry deals with macroscopic phenomena in terms of microscopic structures of matter. It is aimed to understand and explain the chemical structure, investigate the dynamics of processes and reactions, and change in energy during chemical reactions. Chemical literacy in the context domain deals with chemical knowledge that explains daily phenomena, understands the relationship between innovation in chemistry and sociological processes. Chemical literacy in the skill domain deals with the ability of individuals to ask questions and find information that is interconnected. Chemical literacy in the affective domain deals with how chemically educated individuals deliver their chemical views and can express interest in chemical issues and topics. If students have the skills in using the information to solve chemical problems (valid arguments with pro and contra ideas), it means that they have a high level of chemical literacy [11].

Responding to the need of technology-based learning media as an innovation in education, an Android-based smartphone application is developed. A smartphone equipped with an Android operating system is possible to be used as an online learning media or currently better known as M-Learning [12]. The application developed in this research is aimed to provide a flexible and practical chemical literacy evaluation tool for students in grade 11. The application is called AVALIMA. This application provides chemical literacy-based chemistry questions, like the ones appear in PISA, but have been adjusted to the level of competence of the eleventh-grade students.

The purpose of developing AVALIMA media in this study is to know the feasibility and the perception of teachers and students towards AVALIMA media as an android-based application to evaluate chemical literacy in grade eleven. In this case, the researchers assume that all the reviewers and the students have Android-based smartphones. For the parameter of success in this study, AVALIMA media is assumed to be suitable to be used as a chemical literacy evaluation tool for grade eleven if the results of the review given by the reviewers is at least B.

2. Methods

2.1. Research Procedure
The procedure of this study was carried out by adapting the research methods used by Thiagarajan, Semmel, and Semmel [13] which takes only the first 3-D from the 4-D model. This model is a simple instructional model that helps the researcher in producing the android based media to evaluate students’ chemical literacy. This 3-D model only covers define, design, and develop; excluding disseminate. The disseminate stage could not be conducted in this study due to the fact that the steps done in the development level was not yet perfect. The stages done in the development procedure are presented in Figure 1.

![AVALIMA media development procedure diagram]

**Figure 1. AVALIMA media development procedure diagram**

### 2.2. Data Collection

There were two instruments used in this study. The first instrument was an open questionnaire for material experts and media experts to assess the android based media. The second instrument was questionnaire related to the product trial for eleventh grade students who chosen as the respondents.

The questionnaire employed in this study used Likert scale and was adapted from Wahono [14] and OECD [9] which covers the aspects to be assessed from a technology-based learning media and chemical literacy. These aspects were then further developed into 20 assessment indicators. The Likert scale used in this questionnaire was ranging from very good, good, fair, less and poor. Table 1 and Table 2 show the blueprint of the questionnaires developed for the reviewers and the students.

### 2.4. Data Analysis Technique

#### 2.4.1. Data of Product Development Process

The data collected for the product development process was in the form of input and suggestions from material experts and media experts. This data was qualitative data which used to revise the android based media.
Table 1. The Blueprint of the Questionnaire Developed for the Reviewers

| No. | Aspect                  | Sum of Indicator |
|-----|-------------------------|------------------|
| A   | Material                | 4                |
| B   | Science Literacy        | 3                |
| C   | Construction            | 3                |
| D   | Language                | 3                |
| E   | Visual Appearance       | 3                |
| F   | Program Performance     | 4                |

Table 2. The Blueprint of the Questionnaire Developed for the Students

| No. | Aspect                  | Sum of Indicator |
|-----|-------------------------|------------------|
| 1.  | Material                | 3                |
| 2.  | Language                | 3                |
| 3.  | Visual Appearance       | 3                |
| 4.  | Program Performance     | 4                |

2.4.2. Data of Product Quality
The data of product quality was obtained from the questionnaire filled by the reviewers and the students. Then, it was further analyzed by using descriptive data analysis by employing the following steps:

2.4.2.1. Converting the feedbacks given by the reviewers and the students into quantitative data by using a Likert scale. Scoring scale of data was: very good scored by 5, good by 4, fair by 3, less by 2 and poor by 1.

2.4.2.2. Calculating the average score of each aspect and also the overall aspects. The following is the formula used to calculate the average score:

\[ \bar{X} = \frac{\sum x}{n} \]

Note:
- \( \bar{X} \) = average score for overall aspects/ average score for each aspect
- \( \sum x \) = the total score of overall aspects/the total score of each aspect
- \( n \) = the total number of the reviewers/the total number of the students

2.4.2.3. Converting the average score obtained into qualitative data in order to determine the quality of the Android-based Chemical Literacy Evaluation Application (AVALIMA) by using the ideal assessment criteria proposed by Widoyoko [15].

2.4.2.4. Determining the quality of the Android-based Chemical Literacy Evaluation Application (AVALIMA) by referring the average scores obtained to the ideal assessment criteria.

3. Result and Discussion
The results of the development research carried out consisted of two data, namely the development process data and the product quality data. Data on the development process of Android-based AVALIMA media was obtained from conducting define, design, and develop stages. Meanwhile, the product quality data was obtained from the feedbacks by the reviewers and the ten eleventh-grade students chosen as samples.
The reviewers involved to give feedbacks toward the AVALIMA’s media quality were five chemistry teachers from SMAN 7 Yogyakarta, SMAN 2 Klaten, SMAN 1 Prambanan Klaten, SMAN 1 Cilacap, and MAN 1 Sleman. Meanwhile the reviewers asked to give feedbacks for the product trial were ten eleventh-grade students of MAN 3 Sleman. The results of the AVALIMA media quality feedbacks by the reviewers can be seen in Table 5.

Table 3. The Results of AVALIMA Media Quality Assessment by Reviewers

| Reviewer | A | B | C | D | E | F | Σ |
|----------|---|---|---|---|---|---|---|
| 1        | 16| 10| 12| 12| 12| 16| 78|
| 2        | 16| 12| 13| 12| 12| 20| 85|
| 3        | 19| 14| 14| 15| 15| 20| 97|
| 4        | 16| 12| 12| 12| 15| 17| 84|
| 5        | 20| 14| 15| 14| 15| 19| 97|

\[ \bar{X} = 17.4 \text{ very good} \]

Information:
A : Material Aspect
B : Science Literacy Aspect
C : Construction Aspect
D : Language Aspect
E : Visual Appearance Aspect
F : Program Performance Aspect

The following is the comparative percentage diagram of the six aspects based on the feedbacks given by the reviewers.

![Figure 2. Comparative percentage diagram based on the reviewers’ feedbacks on the six aspects measured](image-url)
The questionnaire distributed to the students only consisted of four aspects: material, language, visual appearance, and program performance. The results of the students’ feedbacks on the four aspects while trying out the AVALIMA media can be seen in Table 6.

**Table 4. The results of AVALIMA media trial by the students**

| Value | Aspect | A  | B  | C  | D  | Σ   |
|-------|--------|----|----|----|----|-----|
| Percentage | 86.31 |
| Quality Criteria | very good | good | good | very good | very good |

Information:
A : Material Aspect
B : Language Aspect
C : Visual Appearance Aspect
D : Program Performance Aspect

The following is the comparative percentage diagram of the four aspects based on the feedbacks given by the students regarding to the media trial they had

![Figure 3. Comparative percentage diagram based on the students’ feedbacks on the four aspects measured](image)

Based on the result of the feedbacks given in material aspect, it can be indicated that the materials provided in AVALIMA media are in accordance with the basic competences (KD) stated in Curriculum 2013, particularly the ones that should be achieved by the eleventh-grade students while learning Chemistry subject. The questions given are also in accordance with the eleventh-grade students’ level of competence. The questions compiled are considered to cover chemical concepts and theories related to scientific phenomena in daily life. According to Fives, Huebner, Birnbaum, & Nicolic [16] scientific literacy is an ability to understand scientific processes and scientific information in everyday life meaningfully. Thus, it can be said that the questions in AVALIMA media convey the chemical literacy.

Based on the result of the feedbacks given in the chemical literacy aspect, it can be indicated that the problem formulated has conveyed chemical literacy. The chemical literacy here is further broken down into content and context. The content is said to convey chemical literacy if the questions and
materials given contain chemical materials, such as processes and reactions, changes in chemical energy, and chemical structure. Then, the context is said to convey chemical literacy if it deals with anything happens in everyday life or phenomena related to chemistry and the relationship between chemistry and other sociological processes.

Chemical literacy is related to other sciences. So chemical literacy does not only concern about chemistry, but there can also be integrated biology, physics, mathematics, and other sociological subjects. Most of the studies on the identification of chemical literacy are based on studies of scientific literacy, just as scientific chemical science measurements are also based largely on the same study of scientific literacy [17].

The results of the feedbacks given in the construction aspect can be used as a reflection of the construction of the questions that has been formulated. One set of multiple choices question consists of stem, option, key, and distractor. In this type of question, there is only one right answer; there is no question that depends on other questions; and some questions may have to be solved through several steps.

Based on the result of the feedbacks given in the linguistic aspects, it can be indicated that the products have followed the Indonesian rules stated in EYD. Besides, the questions and discussions provided have also used communicative language, are easy to understand, and do not cause multiple interpretations. The length of the sentences or paragraphs used to convey chemical literacy is also appropriate to the students’ level of competence.

Based on the result of the feedbacks given in the visual appearance aspect, it can be indicated that the type and size of the font (font), background, and display color are appropriate. The AVALIMA media uses Calibri font, 12 points. The background used is designed by using Photoshop CS6. The color chosen for AVALIMA media is green. The students could give better feedbacks on the aspect of visual appearance because the appearance of the application attracts the eyes.

The results of the feedbacks given in the AVALIMA media program performance aspect show that the product has compatible properties, easy navigation, user friendly, and easy to install. Compatible means that the product can be used on all smartphones with android platforms (at least Jellybean) smoothly, stably, and accurately. Easy navigation means that the product is easy to operate, not confusing, interactive, and form and its location is consistent. User friendly means that the product or media is easy to use and simple in operation [13]. The product is claimed to provide easy installation since it can be installed by only downloading it or sharing it by using Bluetooth, WhatsApp, email, etc. For future researcher who wants to conduct development research in the same area of interest, it is recommended that the technology projects to be developed is not only compatible for Android phones, but also other mobile applications or smartphones by testing the effectiveness and efficiency of a group of users [18].

4. Conclusion

Based on the findings and the discussion of this study, it can be concluded that (1) AVALIMA media is feasible to be developed as a media for chemical literacy evaluation for the eleventh-grade students since it is found that the ideal percentage calculated from the feedbacks given by the reviewers and the students is high, that is 88.2% and 86.31%, (2) The teachers’ and the students' perceptions toward this Android-based AVALIMA media as an application to evaluate chemical literacy of the eleventh-grade students is very good.

Based on the results of this study, there some suggestions could be highlighted as the following:

4.2.1. Future researchers need to make sure if the the level of difficulty of the questions given and the number of options provided in multiple-choice items is appropriate for the eleventh-grade students.

4.2.2. AVALIMA media should be used as a teacher’s evaluation tool and students' independent learning media in understanding and recognizing chemical literacy questions.

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