

Developing Android-Based Media for Evaluating Chemical Literacy of Senior High School Students

M. Dihan Ismunandar^{1,*}, Sri Atun², Erfan Priyambodo²

¹ Master of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia

² Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia

*Corresponding author. Email: mdihanismunandar12@gmail.com

ABSTRACT

This research aimed to see the viability and expectations of android-based media by teachers and students as a way of assessing chemical literacy in students of Class X Senior High School. A 4D development procedure with the phases of identifying, designing, and improving dissemination was used in this research. For feedback and input, initial media items are reviewed by content experts, media experts, and peer reviewers. Media reviews and studies are also available, including five chemistry educators with an examination of six aspects, namely content, science literacy, construction, language, visual appearance, and performance programs. In a limited manner, the media was also tried out on twentieth grade students. The results of the study were android-based media containing chemical literacy material for class X students. Based on the results of the media assessment, it was said to be very good and could be used as a media for evaluating chemical literacy. According to the reviewer's assessment, 93.4% of the media is suitable for use, while the response of students as media users is 86.31%. Teachers and students' perceptions of this media are very good.

Keywords: *Android, Chemical literacy, Evaluation*

1. INTRODUCTION

The development of information and communication technology (ICT) is growing very fast, this is used in all fields, one of which is in the world of education [1]. The use of ICT in education is in line with the demands of the 21st century where teachers must have digital skills in using learning technology [2]. The use of ICT in learning, especially in the science clump, is needed to support the effectiveness of the learning process [3]. Teachers' perceptions and motivation in the use of ICT are the two main determinants of successful integration of ICT in learning activities [4], [5]. But in reality, it was found that some teachers were not optimally able to use ICT in learning [6]. This is because the existing learning tools are not in accordance with what is needed.

Shape application of ICT by integrating learning systems into mobile devices is known as M-learning [7]. [8] defines M-learning as a unit of educational equipment that is presented in its entirety on a handheld device or laptop. Based on the existing characteristics, some people prefer to describe M-learning on the use of mobile device systems than laptop devices. The choice of M-learning as a medium in learning is due to several advantages,

namely it is flexible, interactive, collaborative, and instant in obtaining information [9].

Smartphone itself is the most trending electronic device used today [10]. This is because there are many advantages offered on smartphones, one of which already supports the operating system. The use of this form of operating system on cellular phones in Indonesia between October 2019 and September 2020 is dominated by androids with a percentage of 50.56 % focused on the results of Stat Counter research [11]. Android is the most widely used platform because it is considered easy to use and has many features that facilitate user activity [12]. Seeing this fact, the use of android as a supporting or working device has great potential to be developed.

Evaluation in learning can be interpreted as an effort that focuses on the successes and failures of the hopes and goals to be achieved [13]. The evaluation itself plays an important role, because with the evaluation and adjustments in learning it will be more effective and student achievement results can be saved [14]. Questions or tests are needed because they can be used as a basis for

assessment in learning. Assessment is a component part of evaluation, so that in every learning process it is necessary to assess students. Assessment actions are needed to meet specific objectives and directly on a subject matter on an ongoing basis [15]. However, so far the tests, measurements, and evaluations have been less attention to their effectiveness in learning [16]. [17] stated assessment can be effective in helping students learn, if the content and character of the assessment is improved.

In school, many students have difficulty learning, especially chemistry [18]. Chemistry as a complex and dynamic subject is an explanation for this difficulty [19]. If students have strong chemical literacy, this difficulty can be overcome. There are four domains of chemical literacy itself, namely matter, meaning, ability, and effectiveness [20]. Chemical literacy is part of scientific literacy that combines elements of information, skills and attitudes needed to understand and solve environmental problems [21]. Therefore, students need chemical literacy skills to better understand chemistry. However based on PISA data measurements, Indonesian students only rank 75 out of 80 countries surveyed on the reading aspect [22]. The low PISA rating is in line with Indonesian students' low literacy skills. Therefore, through critically examining and reflecting, it is very important to have questions that will help students understand a problem better. The development of PISA questions is in line with the demands in the 2013 curriculum so that students can think more scientifically and critically in response to natural phenomena. One way to overcome this can be done by developing types of chemistry questions that promote the context of scientific literacy.

Learning media are used as a means of connecting to convey information and influence student learning. Therefore, technological innovation in learning can be done by producing learning media that can measure student learning outcomes. During this time, the most widely used use of technology in learning assessment is the use of Online Test with computer devices [23]. In addition, other research findings show that the integration of quizzes into mobile devices can increase satisfaction and motivation in the learning process [24]. However, this is a limitation due to the need for inadequate computer equipment and internet access. Seeing this, researchers developed an evaluation application in chemistry learning on mobile devices without the need for internet access. Use mobile devices accompanied by continuous technological advances will be the key to making m-learning a powerful learning tool [25]

2. METHOD

2.1. Research Procedure

The research procedure carried out in producing the media adapted the 4-D research method developed by Thiagarajan, Semmel, and Semmel [26] by simply doing the first 3-D steps. This model of development was selected because it is easy and allows researchers create android-based media to test the chemical literacy of students. This 3-D model covers the phases of concept, design and creation without dissemination. In this analysis, the phases of product dissemination and public socialization cannot be carried out since the implementation steps taken at the stage of product development are not yet perfect. In Figure I, the phases of the creation procedure carried out in this study are presented.

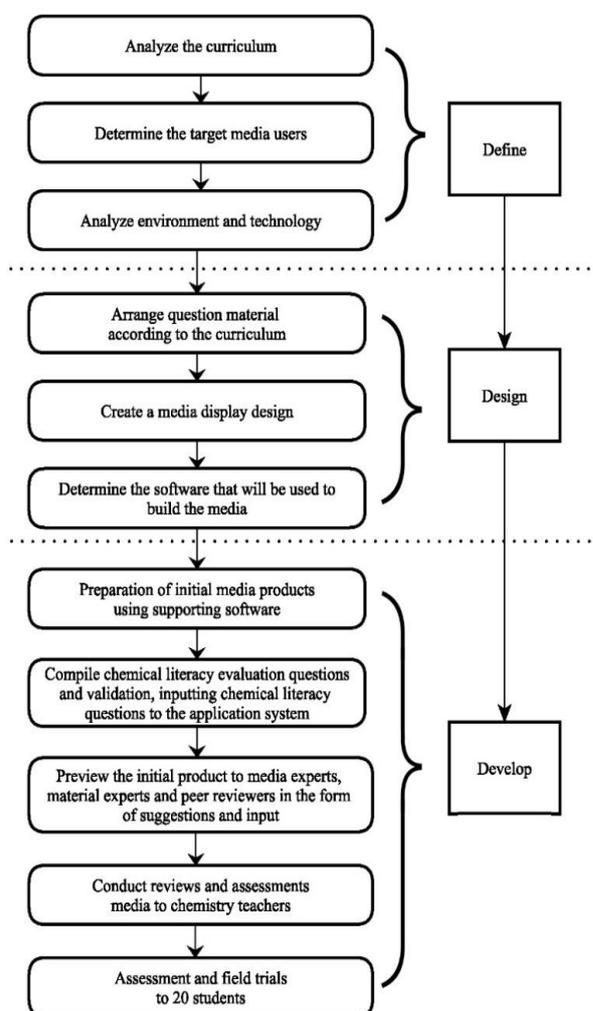


Figure 1. Media development procedure diagram

2.2. Data Collection

In this analysis, there are two types of tools used. The tool includes an open questionnaire to test the produced android-based media provided to reviewers. The next instrument in the form of a product trial questionnaire was given to respondents as many as 20 students in class X in Senior High School.

The questionnaire used in this study was adapted from Arsyad [27] and the OECD [28] by using a Likert scale. The assessment of the media developed includes aspects of learning media based on information technology and chemical literacy. The evaluation aspects formed in the questionnaire were comprised of 6 categories with 20 evaluation indicators. In this questionnaire, the Likert scale used varies from very decent, good, moderate, less and very bad. Table 1 and Table 2 present the aspects of the evaluation questionnaire built for reviewers and students.

Table 1. Aspect of the assessment questionnaire for reviewers

No.	Aspect	Number of Indicators
1	Material	4
2	Chemical Literacy	3
3	Construction	3
4	Language	3
5	Visual Appearance	3
6	Program Performance	4

Table 2. Aspects of the assessment questionnaire for students

No.	Aspect	Number of Indicators
1	Material and construction questions	4
2	Language	2
3	Visual Appearance	3
4	Program Performance	4

2.3. Data Analysis Technique

Qualitative data in the form of input and recommendations from content experts, media experts and five peer reviewers is data collected about the media production process. To revise Android-based media, findings from the qualitative data collected were used.

The resulting product quality data is obtained from the results of the evaluation of the questionnaire given to

reviewers and students. The findings obtained were further evaluated using descriptive analysis steps as follows:

Converting responses and feedback given by teachers and students into quantitative data. The data scale of the data assessment uses the rules of Ary et al [29]. with a Likert scale: very good score 5, good 4, medium 3, less 2 and very less 1.

Calculating the average score for each aspect of media assessment using the formula:

$$\bar{x} = \frac{\sum x}{N}$$

note:

- \bar{x} = value of all aspects
- $\sum x$ = total score of all aspects
- N = the total number of reviewers

Converting the average score obtained into qualitative data with the ideal evaluation criteria to assess the output of the media [30].

Determine the overall quality with reference to the average score obtained with the ideal assessment criteria.

3. RESULT AND DISCUSSION

The results of the development research conducted consisted of two statistics, one on data on the process of media development and the other on data on the content of the media being produced. The product development process data is obtained from the process stages carried out in the development of this media media, namely the definition, the design stage, and the develop stage. Media quality data were obtained from the results of input and suggestions by reviewers, namely five chemistry teachers. The reviewers involved are teachers from five schools in the D I Yogyakarta area and understand technological developments in learning. The five teachers of chemistry are SMAN 7 Yogyakarta, SMAN 1 Sleman, SMAN 2 Sleman, SMAS GAMA, and MAN 1 Yogyakarta teachers. The reviewer teacher assessed the media based on 6 aspects as shown in Table 1. The data obtained were analyzed for each aspect and determined the quality category and ideal percentage for each aspect of the assessment as presented in Table 3.

Table 3. Media quality assessment results by reviewers

Reviewer	Aspect Criteria						Σ
	I	II	III	IV	V	VI	
A	20	15	15	14	15	19	98
B	18	15	15	15	13	20	96
C	19	14	14	14	13	18	92
D	17	13	14	12	15	18	90
E	16	12	14	15	15	19	91
\bar{X}	18	13.8	14.4	14	14.2	18.8	93.2
%	90	92	96	93	94.7	94	93.2
Quality criteria	Very good	Very good	Very good	Very good	Very good	Very good	Very good

information:

- I : Material Aspects
- II : Aspects of Chemical Literacy
- III : Construction Aspects
- IV : Linguistic Aspects

Media quality data, apart from being obtained from reviewer assessments, was also obtained from limited test results on twenty X grade students at SMAN 1 Minggir. The assessment questionnaire that was distributed to students consisted of only four aspects according to Table 2. The results of students' responses to the four aspects during media trials can be seen in Table 4.

Based on the results of the input given to aspects of the material contained in the media, the chemistry materials of Senior High School are in class X reviewed with the aspect of chemical literacy and adjusted to the basic competencies and learning objectives contained in the 2013 curriculum. Each question is in accordance with the scope of material including chemical concepts and theories. The indicators for each item are also consistent with chemical literacy goals, namely the ability to identify chemical concepts, to relate them to daily life, to respect the importance of chemical information and applications, and to be aware of the effect of chemistry on the social environment [31]. The questions are accompanied by a discussion that is in accordance with the scope of the material prepared and inputted in the media.

Table 4. The results of student media trials

Score	Aspect Criteria				Σ
	I	II	III	IV	
	18.05	8.7	13.25	18.25	58.2
%	90.25	87	88	91.25	89.6
Quality Criteria	Very good	Very good	Very good	Very good	Very good

information:

- I : Material Aspects and Problem Construction
- II : Linguistic Aspects
- III : Aspects of Visual Appearance

Based on the results of the feedback given on the aspect of chemical literacy, it can be indicated that the problem formulated has conveyed chemical literacy. Chemical literacy here is further broken down into content and context. Chemical literacy questions were compiled totaling 40 items. The assessment for chemical literacy questions in this study was based on 3 indicators of aspects of scientific competence in PISA 2012, namely a) identifying scientific issues; b) explain scientific phenomena based on scientific knowledge; and c) use scientific evidence to draw conclusions [32]. The following is the distribution of chemical literacy questions published in the media according to 3 indicators of aspects of scientific competence shown in Table 5 below.

Table 5. Analysis of items on aspects of scientific literacy competencies

Competency Aspects	Σ question
Identify Scientific issues	6
Explaining Scientific Phenomena	19
Using Scientific Evidence	15

In the development of chemical literacy questions here, it has paid attention to the competencies needed, namely the question of being able to explain the phenomena of everyday life scientifically. One of the most important domains in chemical literacy [33] namely demanding high-level learning skills, so that it is described that someone with a chemical literacy is able to: a) identify scientific issues; b) explain scientific phenomena; c) Using scientific evidence, and d) evaluating the pros / cons of the debate.

In the construction aspect, the feedback received shows that each set of multiple choice questions is appropriate, consisting of stem, answer options, answer keys, and distractors. In each question there is only 1 correct answer; no question depends on another question;

and some questions require more than one step completion.

In the linguistic aspect based on the feedback provided, it can be indicated that the content presented is in accordance with the rules of Indonesian as stated in EYD. Every sentence used is well structured so that it can be communicative to its users, not multiple interpretations and easy to understand. Editors on each question have delivered chemical literacy and adjusted to the level of understanding of students.

Based on the results of the feedback on the visual aspect, it can be identified that the media uses the android default font type and size which is dynamic. The media is equipped with various animated images and illustrations depicting the title and content of the material developed with Photoshop CS6 software. On the main menu, it contains four main menus, namely, the training menu, exams, help and info, as shown in Figure 2. The selection of the background color used is the blue color theme, where this color provides a better response to the visual aspect of the display. The suitability of the visual appearance can increase students' attention and cognitive ability [34].

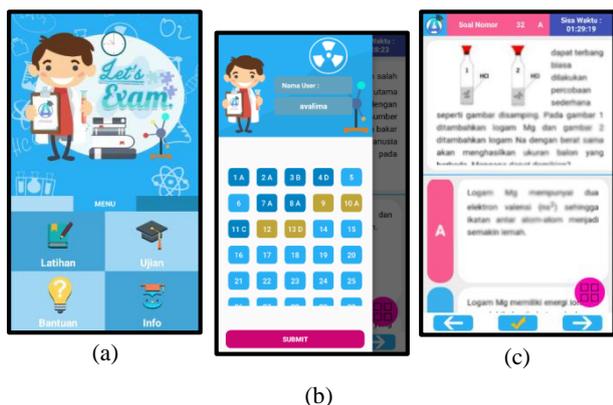


Figure 2 (a) Home view, (b) Question navigation and (c) Display of chemistry questions

Based on the feedback given on performance aspects the program is compatible, easy to use, reusable, and easy to install. Media navigation is very easy, unsafe and a user manual is provided. Media can certainly run well on all Android smartphones with at least version 4.03 (jellybean). The use of this media is easy and can be used as a learning resource independently and simultaneously for testing with a client-server system using MySQL provided by XAMPP. Media has good practicality and mobility for the millennial era, this is considered as a perception that learning with a smartphone screen is easier and more interesting than other resources [35]. The final product of this media has a .apk extension and is easy to get, just download the application then install it on an Android smartphone or share it using email and

social media facilities. Further research is needed for the final outcome of the developed media, namely by measuring the efficacy and efficiency of media usage in the field.

4. CONCLUSION

Based on the results and discussion obtained in this study, it can be concluded that (1) the media that has been created can be used as a tool for evaluating chemical literacy of class X students of high school with a percentage of the results of evaluation and feedback, provided by reviewers and high-level students. In other words, 93.4% and 86.31% (2) the appearance of android-based media by teachers and students as an assessment of chemical literacy by class X high school students is very good.

Several recommendations are made based on the study findings, including (1) further research on the efficacy of media use in assessing the chemical literacy of students is carried out. (2) Create and group further issues of chemical literacy in each sub-section of learning materials and ensure the level of complexity of the questions (3) Take steps to distribute android-based media to educators on a wider scale.

REFERENCES

- [1] F. Length, The Role of ICT in The Teaching and Learning of History in The 21st Century., Educational Research and Reviews 8(21) (2013) 2155–2159. DOI: <https://doi.org/10.5897/ERR2013.1617>
- [2] R. K. Dewi, S. Wardani, N. Wijayati, W. Sumarni, Demand of ICT-Based Chemistry Learning Media in The Disruptive Era, International Journal of Evaluation and Research in Education 8(2) (2019) 265. DOI: <https://doi.org/10.11591/ijere.v8i2.17107>
- [3] J. K. Aina, Effective Teaching and Learning in Science Education through Information and Communication Technology [ICT], IOSR Journal of Research & Method in Education 2(5) (2013) 43–47. DOI: <https://doi.org/10.9790/7388-0254347>
- [4] H. Al-Awidi, F. Aldhafeeri, Teachers' Readiness to Implement Digital Curriculum in Kuwaiti Schools, Journal of Information Technology Education: Research 16(1) (2017) 105–126. DOI: <https://doi.org/10.28945/3685>
- [5] A. A. Qasem, G. Viswanathappa, The Teachers' Perception Towards ICT Integration: Professional Development through Blended Learning, Journal of Information Technology Education:

- Research 15 (2016) 561–575. DOI: <https://doi.org/10.28945/3562>
- [6] M. Drent, M. Meelissen, Which Factors Obstruct or Stimulate Teacher Educators to Use ICT Innovatively?, *Computers & Education* 51(1) (2008) 187–199. DOI: <https://doi.org/10.1016/j.compedu.2007.05.001>
- [7] Y. Mehdipour, H. Zerehkafi, Mobile Learning for Education: Benefits and Challenges, *International Journal of Computational Engineering Research* 3(6) (2013) 93–101.
- [8] J. Traxler, Defining mobile learning, in: *IADIS International Conference Mobile Learning, International Association for Development of The Information Society (IADIS), Lisbon, 2005*, pp. 261–266.
- [9] F. Ozdamli, N. Cavus, Basic Elements and Characteristics of Mobile Learning, *Procedia Social and Behavioral Sciences* 28 (2011) 937–942. DOI: <https://doi.org/10.1016/j.sbspro.2011.11.173>.
- [10] M.A. Osman, A.Z. Talib, Z.A. Sanusi, T. Shiang-Yen, A.S. Alwi, A Study of The Trend of Smartphone and Its Usage Behavior in Malaysia, *International Journal on New Computer Architectures and Their Applications* 2(1) (2012) 275–286.
- [11] G.S. Statcounter, *Operating System Market Share Indonesia Okt 2019 - Sept 2020*, Nov. 2020, [Online]. Available: <https://gs.statcounter.com/os-market-share/all/indonesia>. Accessed: 2 Nov. 2020].
- [12] M. Butler, Android: Changing The Mobile Landscape, *IEEE Pervasive Computing* 10(1) (2011) 4–7. DOI: <https://doi.org/10.1109/MPRV.2011.1>
- [13] J. Edelenbos, A. van Buuren, The Learning Evaluation, *Evaluation Review* 29(6) (2005) 591–612. DOI: <https://doi.org/10.1177/0193841X05276126>
- [14] D. Wiliam, What is Assessment for Learning?, *Studies in Educational Evaluation* 37(1) (2011) 3–14. DOI: <https://doi.org/10.1016/j.stueduc.2011.03.001>
- [15] D. Boud, Sustainable Assessment: Rethinking assessment for the learning society, *Studies in Continuing Education*, vol. 22, no. 2, pp. 151–167, Nov. 2000, DOI: <https://doi.org/10.1080/713695728>.
- [16] D. Adom, J. Adu-Mensah, D.A. Dake, Test, Measurement, and Evaluation: Understanding and Use of The Concepts in Education, *International Journal of Evaluation and Research in Education (IJERE)* 9(1) (2020) 109. DOI: <https://doi.org/10.11591/ijere.v9i1.20457>
- [17] L.A. Shepard, Classroom Assessment to Support Teaching and Learning, *The ANNALS of the American Academy of Political and Social Science*, 683(1) (2019) 183–200. DOI: <https://doi.org/10.1177/0002716219843818>
- [18] G. Sirhan, Learning Difficulties in Chemistry: An Overview, *Journal of Turkish Science Education* 4(2) (2007) 2–20.
- [19] M.B. Nakhleh, Why Some Students Don't Learn Chemistry: Chemical Misconceptions, *Journal of Chemical Education* 69(3) (1992) 191. DOI: <https://doi.org/10.1021/ed069p191>
- [20] Y. Shwartz, R. Ben-Zvi, A. Hofstein, Chemical Literacy: What Does This Mean to Scientists and School Teachers?, *Journal of Chemical Education* 83(10) (2006) 1557. DOI: <https://doi.org/10.1021/ed083p1557>
- [21] D. Mozeika, R. Bilbokaite, Teaching and Learning Method for Enhancing 15-16 Years Old Students Knowledge as One of Scientific Literacy Aspect in Chemistry: Results Based on Research and Approbation, *Journal of Educational Researchers* 3(1) (2010) 1–16.
- [22] OECD, *PISA 2018 Insights and Interpretations*, OECD Publishing, 2019.
- [23] D. Cohen, S. Irit, Online Quizzaz in A Virtual Learning Environment as A Tool for Formative Assessment, *Journal of Technology and science Education* 6(3) (2016) 188–208. DOI: <https://doi.org/10.3926/jotse.217>
- [24] Z. Bogdanović, D. Barać, B. Jovanić, S. Popović, B. Radenković, Evaluation of Mobile Assessment in A Learning Management System, *British Journal of Educational Technology* 45(2) (2014) 231–244. DOI: <https://doi.org/10.1111/bjet.12015>
- [25] B. Sattler, I. Spyridakis, N. Dalal, J. Ramey, The learning experience: A literature review of the role of mobile technology, in: *International Professional Communication Conference in Institute of Electrical and Electronics Engineers (IEEE), IEEE, Piscataway, NJ, 2010*, pp. 38–45. DOI: <https://doi.org/10.1109/IPCC.2010.5529811>
- [26] S. Thiagarajan, D.S. Semmel, M.I. Semmel, *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook*, Wahsington DC: University of Minnesota, 1974.
- [27] Arsyad, *Chemistry Learning Media*, PT Raja Grafindo Persada, 2011.

- [28] OECD, PISA 2015 Result in Focus, OECD Publishing, 2016.
- [29] Ary, Jacobs, Sorensen, Introduction to Research in Education, Wadword, 2010.
- [30] E.P. Widoyoko, Evaluation of The Learning Program, Pustaka Pelajar, 2014.
- [31] S. Celik, Chemical Literacy Levels of Science and Mathematics Teacher Candidates, Australian Journal of Teacher Education 39(1) (2014) 1–15. DOI: <https://doi.org/10.14221/ajte.2014v39n1.5>
- [32] OECD, PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy, OECD Publishing, 2013.
- [33] Y. Shwartz, R. Ben-Zvi, A. Hofstein, The Use of Scientific Literacy Taxonomy for Assessing The Development of Chemical Literacy among High-School Students, Chemistry Education Research and Practice 7(4) (2006) 203–225. DOI: <https://doi.org/10.1039/B6RP90011A>
- [34] K.A. Austin, Multimedia Learning: Cognitive Individual Differences and Display Design Techniques Predict Transfer Learning with Multimedia Learning Modules, Computers & Education 53(4) (2009) 1339–1354. DOI: <https://doi.org/10.1016/j.compedu.2009.06.017>
- [35] S.F.A. Hossain, M. Nurunnabi, K. Hussain, S.K. Saha, S. Wang, Effects of Variety-Seeking Intention by Mobile Phone Usage on University Students' Academic Performance, Cogent Education 6(1) (2019) 1–18. DOI: <https://doi.org/10.1080/233118ossa6X.2019.1574692>