Development of mobile learning integration with scientific approaches on electrolyte solution and redox reaction

U Cahyana*, E Fitriani and W Utari

Chemistry Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, Indonesia

*ucahyana@unj.ac.id

Abstract. This study aims to develop innovative learning media that is mobile learning through scientific approaches on Electrolyte and Redox and to find out the feasibility of media produced. This research was conducted at SMAN 39 Jakarta and SMAN 98 Jakarta from January to May 2019. The research method used is Research and Development (Borg and Gall) by modifying five stages, namely: needs analysis, product development, validation, and product test. The resulting mobile learning media is called "Electrolyte and Redox.apk" that is compatible with Android devices and provides a summary, videos, simulations, quizzes, and educational games. Feasibility test by topic and language expert acquired 83%-100% with 0.808 of reliability. Feasibility tests by media experts acquired 91%-100% with 0.812 of reliability. Media trials by chemistry teachers acquired 88%-100% with "very good" criteria. Media trials by small scale students received 88%, and a large scale gained 92% with "very good" standards. Based on the results, it can be concluded that mobile learning media through the scientific approach in Electrolyte and Redox topic proper to use as a learning media and suitable for students and teachers needed.

1. Introduction
Learning emphasizes the provision of direct learning experience through the development of scientific process skills and attitudes [1]. The curriculum developed at this time is the 2013 curriculum, which demands the creativity of teachers in organizing learning activities and prioritizing the nature of the scientific approach (scientific approach) in learning [2]. This can be seen from the steps of learning through a scientific approach commonly known as 5M, namely observing, asking questions, gathering information, associating, and communicating [3].

Electrolyte solution and redox reaction is one of the materials contained in chemistry learning in class X SMA which consists of the main sub-chapters of electrolyte and nonelectrolyte solutions, redox reactions, and the application of electrolyte solutions and redox reactions in everyday life. In terms of content, electrolyte and nonelectrolyte solution material are in a natural category. Some students can understand the material well, while redox is a material that tends to be difficult because students are encouraged to understand concepts and memorize to solve problems in the material [4]. Based on the results of the questionnaire analysis of the needs of students, as many as 40.2% of students consider the material electrolyte solution and redox reactions challenging to understand. Besides having too much memorization material, as many as 44.8% of students chose material that was presented less attractive. This is reinforced by the data of 94% of students stating that the learning resources they use in learning
electrolyte solutions and redox reactions are textbooks. This difficulty requires teachers to look for alternative strategies in learning activities.

The rapid development of science and technology requires education to participate in the use of technology as a form of innovation in learning [5]. The use of technology-based learning media is one of the applications of 21st-century learning styles [6]. Technology-based learning media makes learning more exciting and has a positive impact on learning motivation and student learning outcomes [7]. The use of technology-based learning media makes learning chemistry more effective and can help teachers limit their information and class hours [8]. In connection with this, it is needed a teaching material that is relevant and easily understood by students and in accordance with the implementation of the 2013 curriculum. One example of technology-based learning media is mobile learning media.

The utilization of mobile learning media in learning activities provides insight into the learning abilities of students by using mobile devices that take place undirected or can be done anytime and anywhere [9]. This is because utilizing technology as a means to present information to students visually and interactively can be more productive and emphasizes the process of independent learning [10]. The use of mobile learning is intended to complement the knowledge and provide opportunities for students to learn material that is not mastered anywhere and anytime [11]. The choice of learning media for mobile learning is also supported by the use of smartphones, which is quite high in Indonesian society. Based on data from the Indonesia Digital Institute in 2019, the number of active smartphone users in Indonesia reached 150 million [12]. Based on the analysis of the needs of students shows that 100% of respondents have mobile phones, and as many as 91.6% of students use smartphones with the Android operating system. This provides an excellent opportunity to innovate learning media by developing the use of mobile learning in the learning process.

Based on the description above, can be formulated the problem "Mobile learning media on the material electrolyte solution and redox reactions through scientific approaches such as what is eligible and suitable to be used as learning media following the needs of teachers and students? And how are the results of the feasibility test on Android-based mobile learning media through a scientific approach to the material electrolyte solution and redox reactions?"

2. Research methodology

The type of research carried out is Research and Development (R&D) research, which refers to the development of Borg & Gall with the research subjects being students of class X IPA SMAN 39 Jakarta and class X IPA SMAN 98 Jakarta. This research was conducted from November 2018 to May 2019.

Based on the ten stages of development, Borg & Gall is simplified into five steps, namely needs analysis, initial product development, expert trials, small scale, and large scale field trials. Expert validation test is carried out by media, material, and language experts. Students and chemistry teachers conduct field trials.

Data collection techniques in this study are to use questionnaires. The first step is to distribute the student and teacher needs analysis questionnaire. After the media was developed, the study continued with the feasibility test by experts in terms of material, language, and media by using a survey of due diligence by experts. After a revision based on the experts' recommendations, the resulting mobile learning media was tested on teachers and students on a small scale and large scale by using a pilot questionnaire by teachers and students.

3. Results and discussion

3.1. Results of needs analysis

Based on the obtained results of the analysis of the needs of students, as many as 40.2% of students stated that the material electrolyte solution and redox reaction is a delicate material. As many as 25.4% of students consider that the material has a lot of memorization, as much as 44.8% of students think that the presentation of the material is less attractive. As much as 43.4% of students say that there are no media that helps to understand better in studying the solution material electrolytes and redox reactions.
As many as 91.6% of students are smartphone users with the Android operating system and 97% of students agree to hold the development of mobile learning media on electrolyte and redox solution materials for use in learning.

Based on the results of the analysis of teacher needs, the teacher said that teachers also need teaching material media that can help in delivering the material. As for the media required, there are writings, pictures, and sound. Therefore, all teachers agree that mobile learning media is developed as a learning media that is expected to help in the learning process. The contents of the mobile learning media that teachers and students want are comprised of learning videos, materials, practice exercises, and educational games.

3.2. Development phase of mobile learning media

The development of mobile learning media consists of several stages, namely designing mobile learning media, making storyboards, choosing software to develop media, and making mobile learning media. Mobile learning media are made according to the needs of students and teachers and adapted to the curriculum used in schools. After that, storyboards are made to simplify the development process because researchers can find out the flow of the media to be made more structured and systematic. The software used to develop mobile learning media is Adobe Flash Professional CS6 with a programming language using action scripts, while the software used to make learning videos in media is Corel Video Studio X10 and Wondershare Filmora 9 as well as making image design and media animation using the CorelDraw X8 (64-bit) software program.

3.3. Media testing phase

The media trial was conducted by three media experts, three material and language experts, students, and teachers on a small and large scale. The aspects tested in the expert feasibility test by media experts are 1) Visualization and audio display and 2) Practicability and Software Engineering. The results of the final assessment of experts on the two aspects assessed can be seen in Table 1. Based on the results of media trials by media experts, the percentage of overall aspects was 91% -100% with very good criteria.

| No. | Aspect                        | Expert 1 | Expert 2 | Expert 3 |
|-----|-------------------------------|----------|----------|----------|
| 1   | Visualization and audio display| 91%      | 91%      | 91%      |
|     | Practicability and Software Engineering | Very good | Very good | Very good |
| 2   |                               | 94%      | 94%      | 100%     |
|     |                               | Very good | Very good | Very good |

Based on the final results of the assessment carried out calculations between the reliability of the rater against the results of the feasibility test data through the Hoyt test formula. The reliability test aims to see the consistency of opinions between evaluators. The result of the reliability of the media feasibility test was 0.812 and was classified as "Very Good." These results indicate the consistency of the results of the rater assessment is very good, and the quality of the developed mobile learning media is good.

After media experts test the mobile learning media, then the media feasibility test is carried out by the material and language experts. The aspects tested in the feasibility test by material and language experts are 1) The suitability of the substance of the contents with the competencies that must be achieved by students; 2) Presentation of material; 3) The relevance of the questions to the discussion; 4) Language; and 5) Relevance of content substance with a scientific approach. The results of the final assessment of material and language experts can be seen in Table 2. Based on the results of media trials by media experts, the percentage of overall aspects was 83% -100% with very good criteria.
Table 2. Material feasibility test by material and language experts.

| No. | Aspect                                                                 | Expert 1 | Expert 2 | Expert 3 |
|-----|------------------------------------------------------------------------|----------|----------|----------|
|     |                                                                        | %        | %        | %        |
|     |                                                                        | Interpretation | Interpretation | Interpretation |
| 1   | The suitability of the substance of the contents with the competencies | 90%      | 95%      | 90%      |
|     |                                                                        | Very good | Very good | Very good |
| 2   | Presentation of material                                              | 83%      | 83%      | 88%      |
|     |                                                                        | Very good | Very good | Very good |
| 3   | The relevance of the questions to the discussion                       | 100%     | 100%     | 100%     |
|     |                                                                        | Very good | Very good | Very good |
| 4   | Language                                                               | 100%     | 94%      | 94%      |
|     | Relevance of content substance with a scientific approach              | 91%      | 98%      | 91%      |
|     |                                                                        | Very good | Very good | Very good |

The results of the reliability of the media feasibility test were 0.808 and classified as "Very Good." These results indicate the consistency of the results of the rater assessment is very good, and the quality of the material and language used in the developed mobile learning media is good.

After the media is said to be feasible based on the feasibility test by the expert, the next is a media trial to small scale students. Respondents in the small-scale media test were 15 students from SMAN 39 Jakarta. Aspects that are tested in media trials to students are 1) The quality of the material, experiments, and questions; 2) Language; 3) Audio and visual display; 4) Implementation and software engineering; 5) Utilization; and 6) The relevance of media content substance to the scientific approach. The results of the final assessment of small-scale students can be seen in Table 3. Based on the results of media trials by small students, the average value of all aspects was 88% with very good criteria.

Table 3. Media trials by students (small scale).

| No. | Aspect                                                                 | Instrument Number | Average Percentage | Criteria |
|-----|------------------------------------------------------------------------|-------------------|--------------------|----------|
|     |                                                                        | 1-7               | 88%                | Very good |
| 1   | The quality of the material, experiments, and questions                | 8 dan 9           | 90%                | Very good |
| 2   | Language                                                               | 10-16             | 87%                | Very good |
| 3   | Audio and visual display                                              | 17-20             | 88%                | Very good |
| 4   | Implementation and software engineering                               | 21-26             | 91%                | Very good |
| 5   | Utilization                                                            | 27-31             | 87%                | Very good |
| 6   | The relevance of media content substance to the scientific approach   |                    |                    |          |

Average Overall Rating: 88% Very good

After the media trial phase is conducted by students on a small scale and then followed by making improvements to the developed mobile learning media, the next process is to test the media of students on a large scale. The purpose of conducting media trials on a large scale is to determine the response and final assessment of the eligibility level by students and teachers of the mobile learning media developed and improved based on input containing criticism and suggestions given at the time of small-scale assessment.

Respondents in the media trial by large-scale students numbered 80 students from SMAN 39 Jakarta and SMAN 98 Jakarta. The aspects that are tested on large scale students are the same aspects that are tested on small scale students. The results of the final assessment of large-scale students can be seen in Table 4. Based on the results of large-scale student trials, it obtained an average value of all aspects tested by 92% with very good criteria. There is an increase in the average of all aspects of the results of small-scale students with large-scale trials.
Subsequent research was conducted by a media test by the teacher. The respondents in the media trial by the teacher were five chemistry teachers at SMAN 39 Jakarta. Aspects that are tested in teacher trials are 1) The suitability of the substance of the contents with the competencies that must be achieved by students; 2) Quality of material, experiments, and questions; 3) Language; 4) Audio and visual display; 5) Technical and software engineering; 6) Utilization; and 7) Relevance of media content substance with a scientific approach. The results of the final assessment of media trials by teachers can be seen in Table 5. Based on the results of the media trial by the second stage of the teacher, the percentage of overall aspects of assessment was 88% -100% with good to very good criteria. Based on the results of teacher trials, there is an increase in the average of all aspects of the results of media trials by the first stage teachers with the second stage.

| No. | Aspect                                                                 | Instrument Number | Average Percentage | Criteria |
|-----|-----------------------------------------------------------------------|-------------------|--------------------|----------|
| 1   | The quality of the material, experiments, and questions               | 1-7               | 92%                | Very good|
| 2   | Language                                                              | 8 and 9           | 91%                | Very good|
| 3   | Audio and visual display                                             | 10-16             | 90%                | Very good|
| 4   | Implementation and software engineering                               | 17-20             | 91%                | Very good|
| 5   | Utilization                                                          | 21-26             | 95%                | Very good|
| 6   | The relevance of media content substance to the scientific approach   | 27-31             | 91%                | Very good|
|     | Average Overall Rating                                               |                   | 92%                | Very good|

Overall, based on media trials conducted to teachers and students, the resulting mobile learning media can be categorized as "Very Good," so it can be concluded that the media can be utilized and feasible to be used as alternative learning media in the chemistry learning process that makes it easy for students to do learning repeatedly.
4. Conclusions
Android-based mobile learning media through a scientific approach to the material electrolyte solution and redox reactions have been successfully developed by adjusting various stages of research. The product produced in this research is an Android-based application called Electrolyte and Redox.apk, which has a file size of 85.9MB, which is compatible with smartphone devices with various screen resolutions and Android operating systems up to version 9.0 (Pie). The mobile learning media produced in this study consisted of learning videos, materials, simulations, questions and discussions, and games.

Based on the results of the media feasibility test by material and language experts, it obtained a percentage of assessment of 83% -100% with a reliability of 0.808 and said to have very good criteria. The results of the feasibility test by media experts obtained a percentage of 91% -100% with a reliability of 0.812 and said to have very good criteria. The results of the media trial by the teacher obtained an assessment percentage of 88% -100% and possessed very good criteria. The results of media trials by students on a small scale obtained a percentage of 88% and on a broad range of 92%, which overall had very good criteria.

Conclusions from the results of trials conducted by researchers is that the Android-based mobile learning media through a scientific approach to the material Electrolyte Solution and Redox Reaction are following the needs of students and teachers and has a very good criterion, feasible, and good to be used as learning media and in accordance with facilities owned by students and teachers.

References
[1] Keyes G 2010 Teaching the Scientific Method in the Social Sciences J. Effective Teaching 2 18–28
[2] Suyanto S 2015 The Implementation of The Scientific Approach Through 5M of The Revised Curriculum 2013 in Indonesia FMIPA UNY 22–29
[3] Abdullah S 2014 Scientific Learning for the 2013 Curriculum (Jakarta: Bumi Aksara)
[4] Haryani S 2014 The Identification of High School Chemistry Materials is Difficult According to the Views of Teachers and Prospective Chemistry Teachers FKIP UNS
[5] Lubis R I 2015 Development of Android-Based Chemistry Learning Media To Increase Learning Motivation and Cognitive Achievement of High School Students. J. Science Education Innovation 1 191–201
[6] Calimag J 2014 Ubquitous Learning Environment Using Android Mobile Application J. Research in Engineering and Technology 119–128
[7] Chuang 2007 Effect of Digital Games on Children’s Cognitive Achievement J. Multimedia 27–30
[8] Bambang W 2008 Learning technologies (Jakarta: Rineka Cipta)
[9] Crompton H 2016 The Use of Mobile Learning in Science Education: A Systematic Review J. Science Education and Technology 149–160
[10] Mayer R 2009 Multimedia Learning (2nd ed.) (New York: Cambridge University Press)
[11] Wirawan P 2012 Development of Web-Based E-Learning Capabilities into M-Learning J. Informatics 21–26
[12] Indonesia Digital 2019 Smartphone Users in Indonesia
### Appendix

**Mobile Learning Display**

| Figure 1. Display the start page of the media | Figure 2. Display the main menu page | Figure 3. Display KD and indicators |
|---------------------------------------------|---------------------------------------|-----------------------------------|
| ![Start Page](image1)                       | ![Main Menu](image2)                  | ![KD Indicators](image3)          |

| Figure 4. Display the learning video | Figure 5. Display material | Figure 6. Video display practicum |
|-------------------------------------|----------------------------|----------------------------------|
| ![Learning Video](image4)          | ![Material](image5)        | ![Practicum](image6)             |
Figure 7. Display of the practical simulation

Figure 8. Display practice questions

Figure 9. Display discussion

Figure 10. Display of the redox reaction quiz

Figure 11. Drag and drop display

Figure 12. Display of chemical puzzles