Development of mobile learning integration with scientific approach in stoichiometry

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Abstract. This study aims to develop mobile learning on stoichiometry based on the scientific approach. Mobile Learning was tested in two different high schools. Research and Development method by Borg and Gall used by modifying stages of need analysis, development, validation, and product test. The result of need analysis indicated necessary media, which provide a summary, exercise, practical video, animation video, and educational games as learning based on scientific support in stoichiometry. 74% of respondents liked mobile learning. At the development phase, designed mobile learning media and storyboard along with software chosen to make mobile learning. The feasibility test of the media produced 88% with a reliability of 0.77. Feasibility test for topic and language feasibility test produced 88% with a reliability of 0.9. Chemistry teacher's test acquired 92% as the best criteria. Small-scale student tests acquired 81%, and big-scale student tests acquired 83% considered as the best criteria. According to this, the study concluded that mobile learning media based on scientific in stoichiometry topic is proper to use and suitable for students and teachers needed.

1. Introduction
Learning media is a tool used by teachers so that learning is more easily understandable by students. Right, learning media used audio-visual based media learning [1]. This happens because this type of media conveys messages received by the senses of hearing and vision at once so that it could raise the percentage of messages stored by the brain more.

A mobile phone is an audio-visual tool that can be used as a medium for learning. A mobile phone is also a form of communication technology that can be accepted by many people [2]. The use of mobile phones and computers in the classroom is an excellent way to exploit the potential of learning and to teach quickly [3]. Media learning using mobile technology is called mobile learning (m-Learning). Mobile media learning can change the way teachers teach [4]. In previous studies, it was found that teachers who use mobile learning feel that mobile phones are useful for improving information retrieval with the latest information [5]. Mobile learning-based learning must continue to be developed because it is one step towards increasing the effectiveness of teaching and learning [6]. Mobile-based learning can open up insights for new learning and support performance on the field, and also provide information access and communication processes anytime and anywhere [7].

The use of mobile learning in teaching and learning is more effective than using traditional learning methods [8]. Students are more resourceful as they can use external resources such as browsers and web [9]. Able to support student performance improvement in learning [10]. As for the results, the scores of students will increase based on their motivation to learn. Besides, learning through mobile can also give...
feedback for incorrect answers when answering questions [11], so students learn their mistakes firsthand and the completion of a question.

Learning is not only supported by learning media, but one of them uses an approach, which is a scientific approach. The scientific method aims to make students more active when learning. The scientific approach races to the 2013 curriculum, which emphasizes the new pedagogical dimension in learning and touches on three domains, namely attitudes, knowledge, and skills. Students are also required to be able to think at a higher level. The scientific approach leads to the activeness of students who refer to the five stages, namely observing, asking, trying, reasoning, and concluding, so that students can produce a functional analysis of learning [12].

Based on the need's analysis, as many as 65% of students consider stoichiometry topic to be difficult to understand, 63% unmotivated while learning, and 54% do not understand well the concept of stoichiometry. As many as 65% revealed that they did not understand stoichiometry because of too many calculations and 67% did not understand the idea of the fundamental laws of chemistry. The teacher also only uses PowerPoint / ICT learning media, and three out of four teachers also stated that they had never used mobile-based media learning. Then, learning media is needed to facilitate students in understanding stoichiometry topics. As many as 74% of students are very interested and motivated if there is a learning media that displays learning in the form of an exciting mobile game. According to the results based on the analysis of the needs, the researcher will develop mobile learning media needed by teachers and students based on science in stoichiometry.

2. Methods
This study aims to design, develop and test the feasibility of mobile media learning based on a scientific approach, so that it can help teachers in the learning process in class X students, especially in stoichiometry. This research was conducted in two different high schools to find out how appropriate this media is used in learning.

Research development carried out refers to the Borg and Gall research and development model. The research phase consists of (1) collecting information (2) planning (3) developing preliminary products (4) initial field testing (5) primary product revision (6) main field testing (7) operational product revision (8) final product revision (9) functional field testing (10) dissemination. This stage is then simplified using Waldopo's theory that research and development related to (1) research (2) evaluation (3) development [13].

3. Results and discussion

3.1. Requirement analysis phase
The needs analysis phase is the initial stage carried out in the study. The results of the needs analysis produced that 65% of students had difficulty understanding stoichiometry. As many as 63% of students are not motivated when learning stoichiometry, 54% of students say they do not understand well the concept of stoichiometry. As many as 67% of students also did not understand well the concepts of basic chemical laws, and 65% stated that the stoichiometric has too many calculations. As many as 63% of students became less active when learning stoichiometry, and 82% of students found it challenging to answer analytical questions. As many as 96% of students stated that students need new and creative learning media to overcome their learning problems. Learners revealed new and innovative media, namely media that contained the summary of the topic with a percentage of 95%, reproduced practice questions related to stoichiometric 86%, there were also educational videos and animations 98% and featured quizzes and games 93% to test the students' understanding. As many as 86% of students also want an independent learning media that is easily accessible, so that it can increase students' understanding on stoichiometry so that it does not cause hardship and boredom when studying it. As many as 74% stated that they were interested and motivated to learn stoichiometry when displayed in an exciting mobile game.
The teacher states that stoichiometric is a topic that is difficult for students to understand with a percentage of 50%. The factors that cause stoichiometric are challenging to understand, namely because of too much memorization (50%) and too many calculations (50%). Teachers also still use the traditional method of lecturing as much as 25%, 50% discussion, and the other 25% is a question exercise. The media used by teachers are 80% in the form of power points / ICT and 20% in the way of blackboards and markers. 100% of teachers have a handphone, but 75% of teachers have never used a handphone as a medium in learning. The teacher also agrees that cellphones could be used as a learning media. The teacher also decides if the development of mobile learning media is carried out on stoichiometry. The aspects needed by the teacher in teaching media are in the form of summary, question exercises, videos, and quizzes.

3.2. Product development stage
There are several steps undertaken for the development of mobile learning media, among others, namely making learning media planning, making storyboards, and the final stage is making teaching media. Determining media planning is based upon the needs of teachers and students in learning. They were storyboarding aims to find out the flow of media developed so that it is directed and systematic. Learning media are created using Adobe Flash CS 6 applications, making videos using Wondershare Filmora 9 and making designs using CorelDraw X7. Then a scientific-based mobile learning media called “Stoikiometri.apk” is produced with a file size of 170 MB and can be used on Android devices such as mobile phones and tablets with version 4.1 (Jelly Bean) to the latest version 9.0 (Pie). The resulting mobile learning media has primary competency content, learning videos, materials, modules and practicum videos, practice exercises and games.

3.3. Product quality test stage
The product quality testing phase was tested on three media experts, three material and language experts, and trials on large and small-scale teachers and students. The aspects assessed in the media feasibility test are (1) audio and visual display and (2) software performance and engineering. The calculation of media reliability gets a result of 0.77 categorized as "good."

### Table 1. Media feasibility test results by media experts.

| No. | Aspect                        | Instrument Item Number | Percentage of Feasibility | Criteria    |
|-----|-------------------------------|------------------------|---------------------------|-------------|
| 1   | Audio and visual display      | 1 to 9                 | 85%                       | Very good   |
| 2   | Software performance and engineering | 10 to 13             | 92%                       | Very good   |
|     | Overall Rating Average        |                        | 88%                       | Very good   |

The aspects assessed in the topic and language feasibility test are (1) Relevance of substance content with competencies that must be achieved by students (2) Content of Topic (3) Relevance of substance of topic content with a scientific approach (4) Relevance of questions and discussion (5) Language. Topic and Language reliability calculations get a result of 0.9 categorized as "very good."

### Table 2. Material feasibility test results by topic and language experts.

| No. | Aspect                                                                 | Instrument Item Number | Percentage of Feasibility | Criteria     |
|-----|------------------------------------------------------------------------|------------------------|---------------------------|--------------|
| 1   | The relevance of the substance of the content to the competencies that must be achieved by students | 1 to 4                 | 81%                       | Very Good    |
| 2   | Content of Topic                                                       | 5 to 8                 | 75%                       | Good         |
| 3   | Relevance of substance of topic content with a scientific approach     | 9 to 13                | 92%                       | Very Good    |
| 4   | Relevance of questions and discussion                                  | 14 to 16               | 97%                       | Very Good    |
| 5   | Language                                                               | 17 to 19               | 95%                       | Very Good    |
|     | Overall Rating Average                                                  |                        | 88%                       | Very Good    |
The aspects assessed in teacher trials are (1) Relevance of substance content and competencies that must be achieved by students (2) Questions and discussion (3) Language (4) Audio and visual display (5) Software performance and engineering (6) Usability.

Table 3. Results of media trials by teachers.

| No. | Aspect                                                                 | Instrument Item Number | Percentage of Feasibility | Criteria     |
|-----|------------------------------------------------------------------------|------------------------|---------------------------|--------------|
| 1   | Relevance of substance content and competencies that must be achieved by students | 1 to 2                 | 92%                       | Very Good    |
| 2   | Questions and discussion                                               | 3 to 7                 | 88%                       | Very Good    |
| 3   | Language                                                               | 8 to 9                 | 92%                       | Very Good    |
| 4   | Audio and visual display                                               | 10 to 18               | 95%                       | Very Good    |
| 5   | Software performance and engineering                                    | 19 to 21               | 95%                       | Very Good    |
| 6   | Usability                                                              | 22 to 23               | 92%                       | Very Good    |

Overall Rating Average 92% Very Good

The aspects assessed in student trials are (1) Questions and discussion (2) Language (3) Visual appearance (4) Software performance and engineering (5) Usability. In the trial, participants were carried out using a small-scale and large scale.

Table 4. Results of media trials by small-scale students.

| No. | Aspect                                   | Instrument Item Number | Percentage of Feasibility | Criteria     |
|-----|------------------------------------------|------------------------|---------------------------|--------------|
| 1   | Questions and discussion                 | 1 to 5                 | 81%                       | Very Good    |
| 2   | Language                                 | 6 to 7                 | 83%                       | Very Good    |
| 3   | Visual appearance                        | 8 to 15                | 76%                       | Good         |
| 4   | Software performance and engineering     | 16 to 20               | 80%                       | Good         |
| 5   | Usability                                | 21 to 26               | 88%                       | Very Good    |

Overall Rating Average 81% Very Good

Table 5. Results of media trials by large-scale students.

| No. | Aspect                                   | Instrument Item Number | Percentage of Feasibility | Criteria     |
|-----|------------------------------------------|------------------------|---------------------------|--------------|
| 1   | Questions and discussion                 | 1 to 5                 | 81%                       | Very Good    |
| 2   | Language                                 | 6 to 7                 | 85%                       | Very Good    |
| 3   | Visual appearance                        | 8 to 15                | 81%                       | Very Good    |
| 4   | Software performance and engineering     | 16 to 20               | 81%                       | Very Good    |
| 5   | Usability                                | 21 to 26               | 89%                       | Very Good    |

Overall Rating Average 83% Very Good

Overall, based on media trials conducted to teachers and students, the result of mobile learning media can be categorized as "Very Good." Coupled with the quiz feature contained in the mobile learning media, students are able to measure their abilities and understanding of chemical concepts without being limited by time and place [14].

4. Conclusions

Based on the development research that has been carried out, a scientific-based mobile learning media called “Stoikiometri.apk” is produced with a file size of 170 MB. The resulting media can be used on android devices in the form of mobile phones and tablets with version 4.1 (Jelly Bean) to the latest version 9.0 (Pie). The resulting mobile learning media has primary competency content, learning videos, materials, modules, practicum videos, practice exercises, and games.

The development of mobile learning media is carried out due to diligence and media trials. The results of the feasibility test of the media experts were 88%, with a reliability of 0.77 with the right criteria. The feasibility test of the topic and language experts was 88%, with a reliability of 0.9 with
excellent standards. The trials conducted on teachers were 92%, small-scale students were 81%, and large-scale students were 83%. Based on the results of the feasibility test of the topic and media experts, the trial of teachers and students at small and large scale produced the final criteria "very good," so it can be concluded that the scientific-based mobile learning media developed has been appropriate to be used following the needs of students and teachers in learning chemistry, especially on stoichiometry.

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## Appendix

| Splash Screen Display | Home Display |
|-----------------------|-------------|
| ![Splash Screen Display](image1) | ![Home Display](image2) |

| Core Competencies | Basic Competencies |
|-------------------|--------------------|
| ![Core Competencies](image3) | ![Basic Competencies](image4) |

| Topic Display | Practice Display |
|---------------|------------------|
| ![Topic Display](image5) | ![Practice Display](image6) |

| Games Display | Exit Display |
|---------------|-------------|
| ![Games Display](image7) | ![Exit Display](image8) |