Development of mobile game base learning on buffer solution to improve student performance

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Abstract. This study aims to develop innovative learning media that is Mobile Learning and know the quality of media produced and know the feasibility of media to be used in learning on buffer solution. This research was conducted at 107 Senior High School Jakarta and 42 Senior High School Jakarta starting in January 2018 until May 2018. The research method used is Design-Based Research which includes 4 stages, namely: (1) needs analysis, (2) development of mobile learning media, (3) Feasibility and trial test. Mobile learning media that generates an app on Android-based smartphones (smartphone) called "ChemBuff" is 167 MB compatible on Android devices up to v.7.1 Nougat with features such as material, video and educational features about the solution buffer. Based on the feasibility test results and the small scale and large scale effectiveness tests, it can be concluded that the mobile learning media is feasible and effective. The result of the effectiveness test shows that there is a very significant difference between the pre-test and post-test value as well as an increase in the average learning outcomes of learners after using mobile learning media buffer solution. The resulting media test can improve student learning outcomes.

1. Introduction
Learning media is considered very important in supporting the learning process and helping students to understand the subject matter. The function of learning media is used to convey messages and can stimulate the thoughts, feelings, attention, and willingness of students so as to encourage the occurrence of deliberate and controlled learning processes. Various types of learning media began to be developed including learning media in the field of ICT (Technology, Information and Communication). Technological innovations in the field of education can be very potential as smart technology media that are used by humans. The positive impact of technological progress is very useful to help the teaching and learning process as well as a learning media. One of the learning media that utilizes technological advances is the media mobile learning on the smartphone (smartphone).

The mobile learning media brings many benefits, one of which is addressing the problem of teachers in time management and increasing the independence of students by using mobile media learning [1]. Students can repeat subject matter wherever and whenever not limited by time and space. Based on recent years, mobile-based learning has gained valid popularity in approaches to complementing traditional teaching or learning processes [2]. This is also supported by data from the Indonesia Digital Association (IDA) survey institute in December 2015, which shows that 96% of Indonesians make smartphones as a mainstay in terms of getting news and other information. Who stated that mobile learning can increase the likelihood of informal learning that is not tied to a particular location [3].
Car-mediated learning media can be a choice of appropriate and effective educational media for high school / equivalent students as a means to increase learning interest in chemistry in schools, as a support for learning resources, or as a reference source for students. This is also supported by previous research which showed that the use of M-GBL learning media (Mobile-Game Based Learning) gave a positive influence on the learning of students. This further reinforces that smartphone technology (smartphone) is a technology that also influences all aspects of people's lives, including in Education. Through the game also provides a self-assessment tool such as a mechanism of scores and the achievement of different levels in a display game. A game can also promote logical thinking, skill development, language skills, communication, personal collaboration, creative and ability to solve problems [4].

Buffer Solution is one of the sub-material contained in the chemistry learning class XI Senior High School / equivalent which consists of the main sub-chapters namely the nature of the buffer solution, the pH of the buffer solution and the role of buffer solutions in living corpses and industries (pharmaceuticals and cosmetics). Concepts of buffer solution had been taught in science class especially in chemistry. Many students assume that buffer is one of the most difficult material in chemistry [5]. Buffer solution relate with other concept such as chemical equilibrium, acid/base chemistry, the particulate nature of matter, chemical reactions, stoichiometry, solution chemistry [6]. To learn buffer solution material, student must understand about macroscopic, microscopic, and symbolic perspective [7]. Many teachers still used traditional approach in learning. They taught all material and students only listen and read textbook. However, if students do not understand the concept from those courses, they will not be able to understand their textbook [8]. Buffer solution is one material from the branch of chemistry that is very closely related to human life. Chemical material is included in the category of branches of science that have various kinds of concepts that must be understood in each learning process. But the fact is that the problem is that students have not been able to interpret abstract concepts and have limitations in relating relationships between concepts so that there are many misunderstandings chemical concepts. Therefore, we need a fun learning media to support the learning process. This study aims to develop innovative learning media that is Mobile Learning and know the quality of media produced and know the feasibility of media to be used in learning on buffer solution.

2. Research methods

The type of research conducted is Design-based Research which refers to the development, with research subjects being class XI Science 107 Senior High School Jakarta students and 42 Senior High School Jakarta. The study consisted of three main stages, namely: needs analysis, media development, data, and feasibility testing & media trials.

3. Results and discussion

3.1. Stages of need analysis research

Based on the results of the needs and preliminary analysis, it can be seen the initial data of information related to the object to be examined, namely students and teachers, and to find out what needs are needed to support the learning process needed interesting and creative learning to help understand the buffer solution material and according to 91% of students are interested and motivated to learn buffer solution material when displayed in the form of mobile learning.

Based on the results of the needs analysis and introduction to the teacher, it can be seen that 50% of teachers have limited time and media limitations in the learning process of buffer solution material, so that it makes some teachers accustomed to learning using the lecture method, this is reinforced by the results of 100% teachers agreeing requires an interesting and independent media teaching material that is easily accessible to students.

3.2. Stages of mobile media learning

Development This stage refers to the results of the needs and preliminary analyzes that have been carried out previously and serve as the main guide in developing mobile learning media. The name of this
learning media is "ChemBuff" (Chemistry Buffer). Making mobile learning media is carried out in stages, the stages of product development are in the form of making material scenarios, making storyboards, and making learning media using Unity software with the Android SDK programming language (Software Development Kit). Furthermore, mobile learning media added sound effects, animated images and videos and games.

3.3. Stages of feasibility test and media trial

3.3.1. The stage of feasibility testing by material and language experts and media experts. This stage aims to obtain information in the form of improvements, suggestions, and constructive criticism for the evaluation and revision of the "ChemBuff" media in order to produce good and quality media products. The following is a description of the results of the media and language feasibility test.

Table 1. "ChemBuff" mobile learning media language and materials expert feasibility assessment results.

| Number | Aspect                                      | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------------|------------------------|------------------------|----------|
| 1      | The relevance of the substance content       | 1,2-3                  | 95%                    | Very Good|
| 2      | Questions and discussion                    | 4-10                   | 89%                    | Very Good|
| 3      | Language                                    | 11-12                  | 90%                    | Very Good|
|        | **Average Overall Rating**                  |                        | **91%**                | Very Good|

Media assessments by material experts and languages assessed by 5 chemistry lecturers, this assessment includes three aspects consisting of 12 indicators. Based on table 1, the evaluation percentage is 91% (category "Very Good") and Based on the calculation of reliability using the Hoyt formula on the results of the feasibility test by Material and Language Experts the reliability value is 0.83 which is classified as "Very Good".

Table 2. Feasibility test results by media experts.

| Number | Aspect                                      | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------------|------------------------|------------------------|----------|
| 1      | Audio and visual display                    | 1-9                    | 85%                    | Very Good|
| 2      | Affection and software engineering          | 10-13                  | 90%                    | Very Good|
|        | **Average Overall Rating**                  |                        | **88%**                | Very Good|

Media assessments by material experts and languages were assessed by 5 chemistry lecturers, this assessment included three aspects consisting of 13 indicators. Based on table 2, the assessment percentage is 88% (category "Very Good") and Based on the calculation of reliability using the Hoyt formula on the results of the feasibility test by Material and Language Experts the reliability value is 0.70 which is classified as "Good".

3.3.2. Trial phase by small scale students. In the small-scale trials that have been carried out there are 20 respondents of students of class XI Science who came from 107 Senior High School Jakarta. Students fill in the questionnaire containing 26 items of statements, based on the data obtained:
Table 3. Feasibility test results by small scale students.

| Number | Aspect                                | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------|------------------------|------------------------|----------|
| 1      | Questions and discussion              | 1-5                    | 89%                    | Very Good|
| 2      | Linguistic                            | 6-7                    | 86%                    | Very Good|
| 3      | Audio and visual display              | 8-15                   | 85%                    | Very Good|
| 4      | Implementation and software engineering| 16-20                  | 86%                    | Very Good|
| 5      | Benefit                               | 21-26                  | 88%                    | Very Good|

Average Overall Rating 88% Very Good

Based on the results in table 3, overall the assessment of small-scale students on the mobile learning media developed has a percentage of 88% (including the category "Very Good").

3.3.3. **Teacher test phase and large-scale student trials.** At the stage of media testing by the teacher this was done by giving the mobile media learning application to 5 different chemistry teachers. Based on the results in table 4, it was found that the overall assessment percentage was 90% (category "Very Good").

Table 4. Teacher feasibility test results.

| Number | Aspect                                | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------|------------------------|------------------------|----------|
| 1      | The relevance of the substance content with the competencies that must be achieved by students | 1-2                    | 95%                    | Very Good|
| 2      | Questions and discussion              | 3-7                    | 89%                    | Very Good|
| 3      | Linguistic                            | 8-9                    | 85%                    | Very Good|
| 4      | Audio and visual display              | 10-18                  | 86%                    | Very Good|
| 5      | Implementation and software engineering| 19-22                  | 93%                    | Very Good|
| 6      | Benefit                               | 23                     | 90%                    | Very Good|

Average Overall Rating 90% Very Good

Table 5. Large-scale student feasibility test results.

| Number | Aspect                                | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------|------------------------|------------------------|----------|
| 1      | Questions and discussion              | 1-5                    | 88%                    | Very Good|
| 2      | Linguistic                            | 6-7                    | 87%                    | Very Good|
| 3      | Audio and visual display              | 8-15                   | 86%                    | Very Good|
| 4      | Implementation and software engineering| 16-20                  | 88%                    | Very Good|
| 5      | Benefit                               | 21-26                  | 95%                    | Very Good|

Average Overall Rating 89% Very Good

Based on the results of the assessment of media trials by students on a large scale, an increase in the percentage of eligibility from the previous one by 88% to 89% with the highest percentage value achieved in the aspects of usefulness.

3.3.4. **The effectiveness of mobile learning media in learning.** The test phase of the implementation of the effectiveness of mobile learning media in the buffer solution material was carried out in class XI Science 3 Jakarta 42 High School which aims to determine the assessment of students related to mobile learning media in buffer solution material, and to test the effectiveness of media in improving student learning outcomes. To be able to know the improvement in student learning outcomes, an initial evaluation in the form of a pre-test is held before learning using supporting media in the form of mobile
learning and post-test after learning using mobile learning media. The results of the effectiveness of mobile learning media in improving learning outcomes can be seen in the following table 6.

**Table 6.** Results of analysis of pre-test and post-test data.

| Descriptive statistical analysis | Data          |          |
|---------------------------------|---------------|----------|
|                                 | Pre-test      | Post-test|
| Lowest score                    | 15            | 55       |
| Highest score                   | 65            | 90       |
| Average score                   | 47.6          | 72.6     |

Based on table 6, the results of the individual pre-test and post-test students obtained an increase percentage of 100%. This shows that the media mobile learning can help improve student learning outcomes as evidenced by the results of the pre-test and post-test which experienced a score increase of 100% from 25 students.

**Table 7.** N-Gain test results.

| Class    | Pre-test average | Post-test average | Criteria        |
|----------|------------------|-------------------|-----------------|
| Experiment | 47.6             | 72.6              | 0.5 Moderate/Fairly Good |

Based on table 7, the N-Gain value is 0.5 ("Medium / Fairly Good" Category) which indicates that media effectiveness in learning is in the category of "Moderate / Fairly Good".

Data normality test is done with the aim to find out whether the data used is normally distributed or not. Normality test using the Kolmogorov Smirnov test with a significance level (α) = 0.05. The normality test using the Kolmogorov Smirnov test was carried out using SPSS 24. In this study α used was 5% or 0.05. Normality is fulfilled if the significance of the data is > 0.05 then it is normally distributed. While if the significance of the data is <0.05, the data can be said to be not normally distributed. The following are the results of data analysis obtained:

**Table 8.** Results of normality data analysis.

| Kolmogorov-Smirnov | Statistic | Df | Sig  |
|--------------------|-----------|----|------|
| Pretest            | .143      | 25 | .200 |
| Posttest           | .127      | 25 | .200 |

Based on the results obtained according to the test in the Kolmogorov Smirnov table that the results of the pre-test and posttest significance were 0.200. This shows that the significance for pre-test and post-test > 0.005, which means that the data comes from populations that are normally distributed. Hypothesis testing carried out in this study using the Paired Sample T-Test method. The paired sample t-test test was used to determine whether there were differences in the average of two paired samples, the paired sample in question was the same sample but had two data, namely the pre-test and post-test data. Following are the results obtained from SPSS 24:
Table 9. Results of paired samples test analysis.

| Paired Sample Test | Paired Differences | 95% Confidence Interval of the Difference |
|--------------------|--------------------|------------------------------------------|
| Mean               | Std. Deviation     | Std. Error Mean                          | Lower       | Upper       | t      | df    | Sig. (2-tailed) |
| Pair 1 POST TEST - PRE TEST | -25.00000 | 10.70436 | 2.14087 | -29.41854 | -20.58146 | -11.677 | 24 | .000 |

Based on the results of table 9 in the paired sample test table, the results show that there is sig. (2-tailed) of 0.000 where the results show that the significance obtained <0.05 by these results indicates that there are significant differences in results between the pre-test data and the results post-test.

The purpose of testing the paired sample t-test also aims to prove the previous hypothesis, the tested hypothesis is

H₀ = The average learning outcomes of students after using mobile learning media in the solution material with the average student learning outcomes before using media mobile learning

Hₐ = The average learning outcomes of students after using mobile learning media in the material of the buffer solution is higher than the average of students before using the media of mobile learning

Decision making for hypotheses is: |t-count>|t-table| then H₀ is accepted and Hₐ rejected, meaning that there is no difference in the average learning outcomes of students before using mobile learning media on the buffer solution material equal to the average student learning outcomes after using mobile learning media.

Based on the table, the value of |t-count| what is obtained is greater than the value of the table at the significance level of 5% or α 0.05, so that H₀ is rejected and Hₐ is acceptable. This shows that there are significant differences between the differences in student learning outcomes based on the scores of the pre-test and posttest results before and after using the mobile learning media on the buffer solution material. Suggests that mobile learning media is very promising in improving student achievement and student interest [9]. Concur that the use of mobile learning has a positive effect on student performance. It also affects the interaction between students and teachers in the learning process and has the impact of learning becoming more active [10].

4. Conclusion

Based on the results of the study it can be concluded that a mobile learning media is produced in the buffer solution material in the form of an Android-based application that was successfully developed. The results of the feasibility and trial test as well as the overall effectiveness test of the media can be categorized as "Very Good" so that it can be concluded that the mobile learning media in the buffer solution material is feasible and effectively used in the learning process. The resulting media test can improve student learning outcomes.

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