Development of mobile learning on acid and base to improve student performance

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Abstract. The aim of this research is to (1) make a Mobile Media Learning on Acid and Base and to determine the quality of the media produced, (2) determine the feasibility of the media used in learning process. The subjects of this research were students of 54 Senior High School Jakarta, 42 Senior High School Jakarta, and 7 chemistry teachers. The research was conducted from January to May 2018. The method used in this research is Design-Based Research. The steps performed in this research are: (1) needs analysis, (2) developing mobile learning, (3) validation test of mobile learning media, (4) media testing by students and small scale of teachers, (5) media trials by students and teachers on a large scale. The results obtained from expert validation tests, small class trials, large class trials, and effectiveness of the media, it can be concluded that the mobile media learning developed in this research is good enough to use in the learning process. The n-gain value obtained from the effectiveness test is 0.76 which can be categorized as high effectiveness, based on the Paired t-test the Tcount value is 28.048. The paired t-test value is Tcount>Ttable (2.03), so it can be concluded that there is a significant difference between pre-test score and post-test score. That difference means that there is improvement in students average score after using the mobile media learning.

1. Introduction
Mobile phone technology can be one of the alternative learning media in the classroom as a teacher's aid in delivering learning. Mobile learning is used as a complement to learning inside and outside the classroom so that learning can be done anywhere and anytime. Mobile learning makes learning innovative so that the learning process can be easier and more enjoyable for students [1]. Mobile learning media developed on cellular telephone devices can be a fun and moveable alternative. Mobile learning can be used as a chemical learning media that is practical, fun, interesting, can be used anywhere and can have a positive effect on student learning outcomes [2].

The material chosen to be applied to mobile learning is acid and base. Acid and base is one of the material in high school level students. Topics of acids and bases require conceptual understanding and are connected with other chemical materials such as particle properties of matter, molecular kinetic theory, properties and composition of solutions, atomic structure, ionization, ionic and covalent bonds, symbols, formulas, equilibrium, and collision theory [3]. Therefore, students experience difficulties in understanding acids and bases. The causes of difficulties in acidic and basic material are derived from material abstracts, complexity of calculations, difficulty of language used in books, different levels of representation, incomprehension of concepts, different learning models, and difficulty in understanding acidic and basic terminology with everyday words. This is supported by the results of a questionnaire analyzing the needs of students that are distributed to students. Based on the questionnaire data obtained
that 67.7% of students from a total of 34 respondents said that acid and base material is difficult to understand. This is reinforced by data from the questionnaire analysis of teacher needs. Three teachers who were made respondents stated that the material was abstract, too many rules, and memorized which resulted in students having difficulty understanding. Based on these findings, acids and bases were chosen as material that will be applied to mobile learning to increase the interest of students in the material and learning media innovations so that students more easily understand the material in a fun way. The aim of this research is to (1) make a Mobile Media Learning on Acid and Base and to determine the quality of the media produced, (2) determine the feasibility of the media used in learning process.

2. Research methods
The research method used in this study is the Design-Based Research which refers to the development model which is a research method used to produce a product and test the effectiveness of the product [4]. Borg and Gall's research procedures can be simplified into five steps, namely: (1) needs analysis, (2) product development, (3) expert validation test, (4) small-scale field trials, and (5) large-scale field trials.

3. Results and discussion
3.1. Needs analysis
The learning resources used by students to study acid and diving bases are fixed on teacher explanations, learning videos, books used by students and the internet. Based on the questionnaire distributed to students Users of smartphones with the Android operating system as much as 61.7%. In addition, many students do not know about mobile learning media that can be used as a learning aid with a percentage of 76.4%. Students have never used mobile learning media in learning with a percentage of 91.2%. Students agree to the development of 88.2% mobile learning media. Meanwhile, the results of the teacher's needs analysis obtained data on the learning resources used by the teacher are the teacher's handbook, modules, and the internet. The number of teachers using smartphones is 66.7%. This is due to the teacher's low knowledge of mobile learning media so that the teacher does not use mobile learning media in learning. The teacher agrees if the development of mobile learning media is carried out on acidic and basic material.

3.2. Mobile learning development stage
The stage of developing mobile learning consists of: (1) the stage of mobile learning planning, (2) the stage of making storyboard media, (3) the stage of software selection, (4) the stage of making mobile learning. At the planning stage, media development is carried out based on the analysis of needs that have been carried out. There are several concepts that are prepared, namely media content scenarios that are a picture of the contents that are in the media. Scenario preparation consists of several activities, namely: selection of material from various sources and adapted to the latest curriculum, decomposition of indicators from basic competencies, summarizing material, exercises and discussion of questions, and preparing a number of questions to be included in the game contained in the media. Furthermore, the storyboarding stage is used as a visualization of ideas developed and makes the making of the media more structured. After creating a storyboard, the next step is to choose software that will be used for the development of mobile learning media. The development of mobile learning media on acid-base material using programs includes Adobe Captivate CC 2017 for programming applications, Adobe Premier CC 2018 for making learning videos and Adobe Illustrator CC 2014 for mobile learning media design. After selecting the software that is used next is the stage of making mobile learning. Output generated is the asambasa.apk application with a size of 75MB. Besides.apk, outputs are also generated in the form of HTML5. The resulting mobile learning media can be played in the latest operating system 3.0. The application is equipped with practice questions and discussions that can be used by students to study. In addition, in the application there are games and simulations of acid and base as a way to make learning more interesting.
3.3. Media validation test
The media that has been designed is then carried out in the media validation test stage. This stage serves to determine the quality and feasibility of the media. Media validation tests include due diligence by media experts and due diligence by material and language experts. This is done in order to obtain criticism and suggestions that are useful for further media development. In the media feasibility test an evaluation of the media is developed. Media expert assessment has two aspects which are divided into ten indicators. The results of expert assessment on the two assessed aspects are found in Table 1, while the assessment of the media by material experts and languages contains three aspects, namely substance relevance of content with competencies that must be achieved by students, questions and discussion, and language. In Table 2 is a description of the aspects of feasibility testing.

Table 1. Media feasibility test results by media experts

| Number | Aspect                                      | Instrument Item Number | Feasibility Percentage | Criteria |
|--------|---------------------------------------------|------------------------|------------------------|----------|
| 1      | Audio and visual display                    | 1-9                    | 91%                    | Very good|
| 2      | Implementation and software engineering     | 10-13                  | 93%                    | Very good|
|        | **Average overall rating**                 |                        | **92%**                | Very good|

Table 2. Media feasibility test results by material and language experts

| 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 and 3              | 97%                    | Very good|
| 2      | Questions and Discussion                    | 4-10                   | 94%                    | Very good|
| 3      | Language                                    | 11-12                  | 90%                    | Very good|
|        | **Average overall rating**                 |                        | **93%**                | Very good|

3.3.1. Results of media feasibility test. The media that had been developed before being tested to students and teachers was first carried out due diligence to media experts. There are five media experts. This test is conducted to see the feasibility of the product, get information, criticism, and suggestions that the learning media produced can be a quality product in programming and appearance. The average score of the overall media feasibility is 92% with the category "very good". Based on the final results, the calculation of the reliability between reters is done to the results of the data. The reliability of the media feasibility test is 0.74 which is classified as "good". These results indicate that the instruments used are reliable, and the quality of the media is good.

3.3.2. Results of language and material feasibility tests. The feasibility test by material and language experts aims to ensure the material and concepts presented in mobile learning are in accordance with content standards and to ensure the language used in mobile learning has been easily understood and does not cause misconceptions. There are five material and language experts. The results of the average assessment of the overall material and language are 93% in the "very good" category. Based on the final results, the calculation of reliability between reters on the results of the material and language feasibility test data can be seen in Appendix 18. The results of the reliability of material and language feasibility tests are 0.88 which is classified as "very good". These results indicate that the instruments used are reliable, and the material quality and language in the media are appropriate.

3.4. Media trial by small scale students and teachers
Small-scale trials are conducted with the aim of obtaining information in the form of input from students as potential media users before being used on a larger scale. There are five aspects of assessment on media trials by students, among others: (1) questions and discussion, (2) language, (3) audio and visual
display, (4) software implementation and engineering, (5) usefulness. Based on the results of trials on small scale students and teachers, data were obtained on these aspects which can be seen in Table 3 and Table 4.

### Table 3. Media test results by small scale students.

| Number | Aspect                                      | Instrument Item Number | Feasibility Percentage | Criteria   |
|--------|---------------------------------------------|------------------------|------------------------|------------|
| 1      | Questions and discussion                    | 1-5                    | 92%                    | Very good  |
| 2      | Linguistics                                 | 6-7                    | 90%                    | Very good  |
| 3      | Visual display                              | 8-15                   | 88%                    | Very good  |
| 4      | Implementation and software engineering      | 16-20                  | 88%                    | Very good  |
| 5      | Benefit                                     | 21-26                  | 95%                    | Very good  |

**Average overall rating** 91% Very good

### Table 4. Media test results by small scale teachers.

| 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                    | 83%                    | Very good  |
| 2      | Questions and discussion                    | 3-7                    | 89%                    | Very good  |
| 3      | Linguistics                                 | 8-9                    | 92%                    | Very good  |
| 4      | Visual display                              | 10-18                  | 87%                    | Very good  |
| 5      | Implementation and software engineering      | 19-22                  | 88%                    | Very good  |
| 6      | Benefit                                     | 23                     | 90%                    | Very good  |

**Average overall rating** 92% Very good

Can be seen in Table 3 aspects of usefulness have the highest percentage of 95%. It can be concluded that mobile learning is very beneficial for students in learning. The ability of mobile learning that allows learning anywhere and whenever learning can not only be done in the classroom. Besides that, mobile learning is more interesting because it has good audio and visual abilities so that learning is easier to understand and understand. Based on the results obtained, the assessment of students on a small scale towards the mobile learning media developed has a percentage of 91% with the criteria of "very good". While the results of media trials by small-scale teachers in Table 4 were the highest percentage of language aspects in the media with a percentage of 92%. This which shows the language used in mobile learning is well understood and does not have multiple interpretations. Based on the assessment given by the teacher, the average overall assessment of the media is 80% with the category "very good". This shows that the media created is appropriate and acceptable to the teacher and can be used as a tool in learning. The results obtained show that the media can be said to be feasible and can be tested on a larger scale.

#### 3.5. Media trials by large scale students and teachers

After the media carried out the small-scale trial phase, it ended with several revisions to the media being developed. After repairing, a trial was conducted on a larger scale. On a large scale a media trial was conducted on five teachers and 100 students. 100 students consisted of 70 students of 54 Senior High School Jakarta and 30 students of 42 Senior High School Jakarta. The purpose of a large-scale trial is to find out the response and final assessment of the level of feasibility by students and teachers with a greater number of mobile learning media developed. Based on the results of trials on large-scale students and teachers, the data obtained from these aspects can be seen in Table 5 and Table 6.
Table 5. Media test results by large scale students.

| Number | Aspect                                      | Instrument Item Number | Feasibility Percentage | Criteria   |
|--------|---------------------------------------------|------------------------|------------------------|------------|
| 1      | Questions and discussion                    | 1-5                    | 92%                    | Very good  |
| 2      | Linguistics                                | 6-7                    | 89%                    | Very good  |
| 3      | Visual display                              | 8-15                   | 92%                    | Very good  |
| 4      | Implementation and software engineering     | 16-20                  | 90%                    | Very good  |
| 5      | Benefit                                    | 21-26                  | 95%                    | Very good  |

Average overall rating 92% Very good

Table 6. Media test results by large scale teachers.

| 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                    | 98%                    | Very good  |
| 2      | Questions and discussion                    | 3-7                    | 95%                    | Very good  |
| 3      | Linguistics                                | 8-9                    | 98%                    | Very good  |
| 4      | Visual display                              | 10-18                  | 92%                    | Very good  |
| 5      | Implementation and software engineering     | 19-22                  | 98%                    | Very good  |
| 6      | Benefit                                    | 23                     | 90%                    | Very good  |

Average overall rating 92% Very good

Based on Table 5, it can be seen that there is an increase in the aspect of visual appearance and software implementation and engineering to 92% and 90%, which was 88% previously. Overall there is an increase in the average assessment of all aspects on a small scale is 91% and on a large scale to 92% there is an overall increase in the media produced. It can be concluded that the resulting media makes it easier for students to learn and understand the material. The average rating of students overall in small-scale media trials is 92% with the category "very good". These results indicate that mobile learning media can be used and properly used by students well. Mobile learning on acidic and basic material has not been found by students so that when shared the application and used for learning students feel interested. This is because mobile learning can be used anywhere and anytime and does not require an internet connection.

After conducting trials on large scale students, a media trial was conducted by a large scale teacher. The media testing by the teacher consists of six aspects of assessment, namely the relevance of substance content and competencies that must be achieved by students, questions and discussion, language, visual appearance, implementation and software engineering and usefulness. Media trials were conducted on five chemistry teachers. Based on Table 6 aspects of substance relevance with competencies that must be achieved by students, linguistics, and implementation and software engineering have a high percentage, namely 98% with the category "very good". These results indicate that the material presented has been in accordance with the competencies that must be achieved by students and the language used is easily understood and understood by the teacher. The implementation and engineering of media software is good and easy to operate by users. Operation of mobile learning without using the internet makes learning easier. Meanwhile, the average assessment of the overall results of media trials by large-scale teachers is 92% with the category "very good". This shows that the media is acceptable and can be used well by the teacher for learning in the classroom.

Comments and suggestions given by the teacher are so that the material in the application can be downloaded. In addition, so that the media can also be downloaded easily by teachers and students. Overall, based on the trials conducted on media teachers and students it can be categorized as "very
good" which can be concluded that the media is feasible to be used as a tool in the chemistry learning process.

3.6. Application of mobile learning in student learning
Media that has finished testing to students, tested the effectiveness of the media on improving cognitive abilities (learning outcomes) of students. Media effectiveness testing was conducted on 36 students of class X Science 4 of 42 Senior High School Jakarta. Media effectiveness is done by looking at the n-gain value. Data obtained from evaluation instruments in the form of pre-test and post-test. The products produced can be said to be effectively used as learning media if there is an increase in the average n-gain score according to the classification according to Hake according to Table 7 [5].

| Table 7. Classification of effectiveness levels. |
|-----------------------------------------------|
| Value                  | Classification |
|------------------------|----------------|
| g > 0.7                | High           |
| 0.3 ≤ g ≤ 0.7          | Medium         |

The pre-test and post-test value data were processed data so that the data obtained increased student learning outcomes (gain) contained in Appendix 28. Based on these data there were 26 students with an increase in high learning outcomes, 10 students with moderate learning outcomes. Based on these data the average increase in learning outcomes (gain) is 0.76 which can be categorized as high according to the classification of Hake's effectiveness level.

Student value data for pre-test and post-test students in addition to the calculated n-gain values were also calculated for data normality and t-test. The normality test aims to test the data obtained having a normal data distribution or not. Good data is normally distributed or near normal. The normality test can be done using the Kolmogorov Smirnov Test method. Decision making is based on the probability value t-statistic> Level of Significant = 0.05, then the data can be assumed to be normal. The following are the results of the Kolmogorov Smirnov Test normality test in Table 8.

| Variable     | Kolmogorov-Smirnov | df | Sig. |
|--------------|---------------------|----|------|
| PRE-TEST     | .132                | 36 | .116 |
| POST-TEST    | .135                | 36 | .096 |

Based on the data from the normalization test above, it can be seen that the probability value of t-statistic> Level of Significant = 0.05, then it can be concluded that the data is normally distributed. After the normality test is carried out the t test. The t test is done to test the hypothesis. The test used is the Paired Sample T-Test on the pre-test and post-test values to find out the difference between the average value before being given a mobile learning (pre-test) with an average value after being given mobile learning.

The hypothesis used is:

H0 : the average pre-test value with the post-test average value

H1 : the average pre-test value is smaller than the post-test average value

Based on probability:

H0 is accepted if it is significant > 0.05
H0 is rejected if it is significant < 0.05

The following are the results of the Paired t-test can be seen in Table 9.
Table 9 Test results Paired t-test.

| Paired Differences | Mean     | Std. Deviation | Std. Error | 95% Confidence Interval of the Difference | t      | df | Sig. (2-tailed) |
|---------------------|----------|----------------|------------|------------------------------------------|--------|----|-----------------|
| POST TEST - PRE TEST| 55.4167  | 11.85478       | 1.97580    | [51.40559, 59.42775]                      | 28.048 | 35 | .000            |

In the table of the results of the Paired t-test the tcount value is 28.048. Meanwhile, the value of table with a significant level (α) = 0.05 is 2.03. Thus, the price of tcount (28.048)> t table (2.03) and based on the table of the results of the Paired t-test obtained the significance of 0.000 less than the significant level (α) = 0.05, then H0 is rejected. It can be stated that there is a significant difference between the value of the pre-test and post-test. It can be concluded that there is an increase in the average test scores of students after using mobile learning base-learning. Technology contributes to the increase in student learning outcomes in higher education [6]. Learning using mobile learning has a significant effect on academic achievement and student discussion skills [7]. The use of mobile learning in learning has a positive effect on student performance [8]. In addition, the use of mobile learning in learning can increase independence because learning can be done anywhere and anytime to increase knowledge [9]. Support this claim that one-way-based learning, using mobile media, can improve learning independence, time management, and critical thinking that can all have a positive impact on student learning outcomes [10].

It can be concluded that the media created can have high effectiveness in improving students' cognitive abilities. This can occur supported by several features contained in mobile learning such as learning videos, questions and discussions, animations, and materials that can be used repeatedly so that it is easier for students to do repetitive learning.

4. Conclusion
Based on the results of expert validation tests, small class media testing, large class media testing, and media effectiveness tests, it can be concluded that the android-based acid and base mobile learning media developed in this study are feasible and good for use in learning Acid-Basa material. In addition, based on media effectiveness test through N-gain and Paired Sample T Test, the resulting media test can improve student learning outcomes.

References
[1] Huang C S J, Yang S J H, Chiang T H C and Su A Y S 2016 Effects of Situated Mobile Learning Approach on Learning Motivation and Performance of EFL Students Educ Technol Soc. 19(1) 263–76.
[2] Cahyana U, Paristiwati M, Savitri D A and Hasyrin S N 2017 Developing and Application of Mobile Game Based Learning (M-GBL) for High School Students Performance in Chemistry EURASIA 8223(10) 7037–47
[3] Sheppard K 2006 High school students’ understanding of titrations and related acid-base phenomena Chem Educ Res Pr 7(1) 32–45.
[4] Borg W and Gall M D 2006 Educational research: An Introduction, Eighth Edition. Eighth Ed. (New York & London: Pearson Education)
[5] Hake R R 1999 Analyzing Change/Gain Scores. AREA-D American Education Research Association’s Devision.D, Measurement and Reasearch Methodology
[6] Tømte C, Kårstein A and Olsen D S 2013 IKT i lærerutdanning. På vei mot profesjonsfaglig digital kompetanse? [ICT in teacher education. Moving towards a professional digital competence?] (Oslo: Nordic Institute for Studies in Innovation, Research and Education)
[7] Elfeky A I M and Yakoub M T S 2016 The Effect of Mobile Learning on Students’ Achievement and Conversational Skills *Int J High Educ* 5(3) 20–31

[8] Jabbour K K 2014 An Analysis of the Effect of Mobile Learning on Lebanese Higher Education *Bulgarian Journal of Science and Education Policy* 13(1) 1–15

[9] Murphy A, Farley H, Lane M, Hafeez-Baig A and Carter B 2013 Mobile learning anytime, anywhere: what are our students doing? *in Hepu Deng and Craig Standing (ed.) ACIS 2013: Information systems: Transforming the Future: Proc., of the 24th Australasian Conference on Information Systems, Melbourne, Australia* 4-6 December pp. 1-12

[10] Broadbent J and Poon W L 2015 Self-Regulated Learning Strategies & Academic Achievement in onway Higher Education Learning Environments: A systematic Review *Internet and Higher Education* Elsevier 27 1–13