Teaching Chemical Equilibrium in High School Using Android-Based Interactive Multimedia

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Abstract. This study aims to determine the improvement of student learning outcomes using the developed multimedia, knowing the effect of learning motivation on student learning outcomes and knowing student responses. The study used the ADDIE model. The sampling technique was purposive sampling in XI grade. The data collection instruments included student learning outcomes and questionnaires on motivation and responses. The learning instrument data from the pretest and posttest were composed of multiple-choice questions analyzed with the Rasch model assisted by the Winstep program. Analysis of data on motivation and learning outcomes by test using SPSS. The results showed an increase in student learning outcomes with an average N-Gain of 0.66 in the medium category, the impact of learning motivation students towards learning outcomes with a percentage of 12.3%, and student responses obtained results of 81.25% in the excellent category.

Keywords: Interactive multimedia, android, motivation, student learning outcome, chemical equilibrium.

1 Introduction

At this time, the high escalation in the fields of science and technology has improved the quality of education, where the development of this technology facilitates learning in science, for example, in chemistry subjects [1]. The teacher's role, which was initially a limited source of learning for students in the 21st century, proliferates as a mediator and facilitator [2]. The use of technology is also able to influence the form of teaching activities so that they can move well [3]. It requires teachers to be able to apply technology in growing learning multimedia.

Chemistry curricula generally incorporate many abstract concepts at the core of further learning in chemistry and other sciences. These abstract concepts are important because subsequent chemistry/science concepts or theories cannot be easily understood if students do not adequately understand these underlying concepts. Chemical equilibrium is one of the subjects in which the scope of chemical equilibrium includes dynamic equilibrium,

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equilibrium equations, and the relationship between Kp and Kc. The concept of chemical equilibrium is central and complex in chemistry is considered one of the most challenging matter in chemistry education [4].

Based on observations, questions, and answers from teachers at school, get information that the learning process uses textbooks, sometimes combined with PowerPoint media. In addition, there is an offline learning system (outside the network) with reduced effective study hours so that not all material can be explained in detail and in-depth, so the existing teaching media are not optimal enough. The need for innovation to increase learning effectiveness aims to increase student learning resources. The teacher also believes that android-based teaching media will be interesting to use in the classroom because Android is ubiquitous and often used, so students will be pleased to use it. If the teaching media developed is practical and contains a summary of colorful and illustrated material, the teacher will be pleased to use it. The description above concludes that interactive multimedia can be used as an additional supplement when studying chemical equilibrium material. Its practical use without space and time limitations and audiovisual media can support learning activities [5] [6]. Therefore, through a combination of several media elements, it is hoped that the learning experience will be more meaningful so that interactive android-based multimedia interactive has advantages, one of which is conveying messages so that the material is more precise [7].

Innovation is needed to increase learning effectiveness, which aims to increase learning resources for students. The learning process more compelling with various efforts, one of which is the use of Android-based interactive multimedia. [8] said that using mobile technology in the botanical learning process can increase motivation and provide a pleasant learning experience. Furthermore, there is a positive relationship between motivation and academic success. [9] mentioned the importance of considering interactive design in developing multimedia materials in the learning environment. The progress of learning media has been achieved significantly to add essential means to achieve educational goals more effectively and efficiently [10]. Research on the use of interactive multimedia using various application program such as was put forward by [11], [12], and [13] has successfully developed. Moreover, [14], [15] and [16] has developed interactive media with Lectora Inspire. When used correctly as a massage tool, the steps and process of using the suitable interactive media will mobilize students' thoughts, feelings, fears, and desires, making the learning process more concrete [10].

The primary purpose of multimedia learning is not only to replace but also to complement the objectives, materials, methods, and evaluation instruments in the teaching and learning process referring to the general system. The multimedia aspect can stimulate the stimulus in the undertaken educational process. The hope is that the application of multimedia can direct changes in the learning environment and can be a criterion and encouragement, especially for participation in teaching, to improve learning outcomes, and as an alternative to education [17]. Learning media can also actively involve students in the learning process to increase students' comprehension of the taught material [18]. Many studies reveal the advantages of learning using multimedia, including increasing learning motivation [6], [19], [20]. This study aims to improve student learning outcomes and determine the impact of learning motivation on student learning outcomes and student response through enhanced multimedia content.

2 Research Methods

This type of research is development research using ADDIE model consist of 5 stage. The sample was one class. The study's one-group pretest-posttest methodology. Combining literature studies allows for the analysis step. A literature study combines information and references related to the material based on the syllabus. The design stage involves determining ideas and identifying programs, compiling media content outlines, and designing flowcharts and storyboards. The third stage is the development stage, and researchers carry out the manufacture and design of applications. The researcher carries out the implementation stage after the application has been validated. Based on the overall activities completed to produce a product in the form of android-based interactive multimedia, the researcher analyzes the developed android-based interactive multimedia. The measurement of student learning outcomes has been through instrument testing including item fit, reliability, difficulty level, discriminatory, and distractor tests using the Winstep program in associated with the Rasch model. The data collection of students' motivation and responses using questionnaire with Likert scale then converted the percentage to the assessment criteria. The improvement of student learning outcomes were counted using N-Gain formula. Linearity test and correlation test to analyze how learning motivation affects student learning results. The criteria for a valid test can be seen in Table 1.

Table 1. Criteria for a valid test viewed from various criteria

Validity Aspect of the Item	Criteria
Unidimensional test	Scree Plot's factor analysis result
Fit item test	$0.5 < MNSQ < 1.5$ $-2.0 < ZSTD < 2.0$ $0.4 <$ Pt Measure Corr < 0.85
Item difficulty	Very difficult: b (measureing item) > 2; Difficult: $2 \leq b < 1$; Moderate: $-1 \leq b < 1$; Easy: $-2 \leq b < -1$; Very easy: $b \leq -2$.
Reability Person/Item	Weak: < 0.67 Adequate: 0.67 – 0.80 Good: 0.81 – 0.90 Very good: 0.91 – 0.94 Special: > 0.94
Alpha Cronbach	Alpha Cronbach > 0.80 is a good category
Discriminatory	Adequate: 0.20 – 0.29 Good: 0.30 – 0.39 Very good: > 0.40
Distractor	Known from the average logit value of the students who got the correct answer

3 Result & Discussion

Android-Based Interactive Multimedia

Android-based interactive multimedia has been developed according to the ADDIE stages, namely analysis, design, and development. It contain (a) Material menu about chemical equilibrium; (b) Learning Video Menu; (c) Evaluation Menu; (d) User Guide Menu; and (e) Login and Logout Menu. Below is an overview of android-based interactive multimedia in Figure 1.

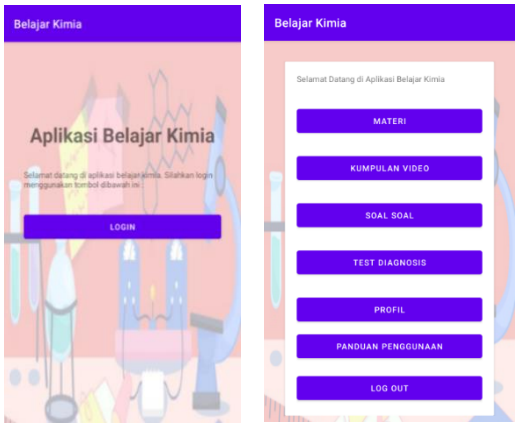

Fig. 1. Overview of Interactive Multimedia

Android-based interactive multimedia has been developed and used as one of the innovation in learning chemical equilibrium. Android Media has a menu of video tutorials and assessment questions. The tutorial includes videos to help you understand chemical equilibrium. The tutorial video can be opened when the device is connected to the internet, and when there is no internet, the video cannot be played. In addition, this learning tool is equipped with an assessment menu that contains two types of assessments, one of them called a diagnostic test. It gives feedback so the students can identify which test category they have not been able to. So as 2 forms of evaluation and feedback are provided, students are able to use it as evaluation material in understanding the material they learn.

Standardization of Research Instruments

Student's learning outcome data was collecting with multiple choice questions analyzed with the Rasch model assisted by the Winstep program. The Rasch model must fulfill several assumptions before being analyzed, namely the assumption of unidimensionality and local independence. With the Winstep program, the unidimensional assumption test meets the minimum criteria of 20% on the eigenvalue results, and the unexplained variance in the first contrast value was obtained at the eigenvalue 3.0. It is necessary to do a dominant factor analysis using Principal Component Analysis (PCA) to ensure that the items only measure one dimension (unidimensional) because one of the criteria is not accomplished.

PCA is determined by analyzing the dominant factor seen from the initial eigenvalue in Total Variance Explained. And it can also be seen from the scree plot graph. The scree plot can be seen in Figure 2.

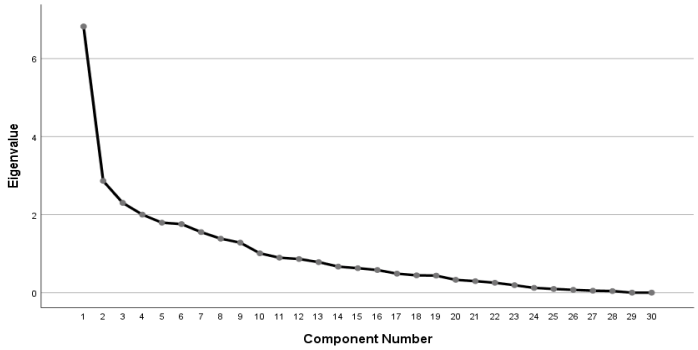

Figure 2. Eigenvalue Scree Plot Graph

The graph showed that there is one sharp steepness from component 1 to component 2, while the graph slows from component 2 to the other components. Thus, the unidimensional assumption test is fulfilled so that the developed assessment instrument can measure what it should measure, and the local independence assumption is automatically proven [21]. After the analysis, it was concluded that the overall test items were quite feasible, and 16 questions were obtained.

Students' Learning Outcomes

Implementation of android-based interactive multimedia was carried out for 35 students in XI grade in the Natural Sciences Mathematics specialization group. The evaluation staged aimed to determine the difference in student learning outcomes after being given research treatment on chemical equilibrium material and to get the conclusion of students' motivation in learning chemistry. The researcher obtained data from the result of pretest, posttest and N-Gain of student learning outcomes after the implementation of the study can be seen in Table 2.

Table 2. Summary of pretest, posttest, and N-Gain data

	Lowest Score	Highest Score	Average
Pretest	35	50	38.45
Posttest	44	100	79.74
N-Gain	0.09	1.00	0.66

Data on improving learning outcomes in research provides information that students achieve an average N-gain score of 0.66 and are in the medium category. The increase in learning outcomes achieved was only in the moderate category due to various factors, one of which was a decline in student academics which was the effect of the online to offline transition process [22]. In this research, the researcher realized that class XI students had never done face-to-face learning while in the high school level. So that it affects the increase in academic

scores, which still do not meet the expected maximum results. Several studies that obtained N-Gain results in the medium category include research by [23], [24], and [25].

Students' Learning Motivation

After the learning process was complete, students were given a motivational questionnaire to measure their level of motivation after being treated using android-based interactive multimedia. The questionnaire contains 25 statements and measures students' extrinsic motivation, including six indicators: attention, belief, satisfaction, challenge, curiosity, and participation. The average level of student motivation is 82.65%, and based on the result, the attention indicator has the highest average score of 85.18%. Students find it helpful and are happy to learn chemical equilibrium with android-based interactive multimedia. This opinion was expressed by [26] and [27]. Students also feel that interactive multimedia fosters a more profound interest and curiosity about chemical equilibrium. It was also explained by [28] that the components of students' interest and curiosity increased well after being taught using media based on Android.

Hypothesis Test

Linierity Test

After getting data on learning outcomes and student motivation, a linearity test will be carried out as an initial requirement for testing hypothesis. The prerequisite test consists of a linearity test at a significance level of 0.05 using SPSS 25 for windows. Tests to measure the dependent variable with independent variables that have a linear or insignificant relationship can be done with the if linearity test. The reference is if the significance value on linearity > 0.05 means that the independent and dependent variables have a linear relationship. The results achieved, namely the Sig value of 0.890 > 0.05, concluded a linear relationship between learning outcomes and student learning motivation.

Correlation Test

After the data analysis requirements test concluded that the two variables had a linear relationship, the next phase was to test the correlation to assess how closely the relationship between the two variables was. If the value of sig < 0.05, then Ho is rejected.

Table 3. Hypothesis Test Results

Hypothesis	Sig	α	Conclusion
H_a: There is an influence between motivation on student learning outcomes H_0: There is no influence between motivation on student learning outcomes	0.039	0.05	H_0 rejected

Based on Table 3, the score is 0.039, indicating that for testing the hypothesis, it has a probability of 0.039 < 0.05, so Ho is rejected. Several studies that obtained positive results between motivation and student learning outcomes are [29] and [30].

The Impact of Motivation on Learning Outcomes

Linear Regression Test

The Linear Regression test investigates the magnitude of motivation's effect on student learning outcomes. This test is to obtain the coefficient of determination which measured (quantity) to define the relationship's strength level in the form of a percent (%).The results of the linear regression test obtained sig < 0.05, namely 0.039 < 0.05, meaning that there is an influence between learning motivation and student learning outcomes.

Coefficient of Determination

The influence percentage determined the correlation test's coefficient of determination. The coefficient of determination (R^2) value shows the rate at which all independent factors impact the dependent variable. The results of the coefficient of determination will be described in Table 4.

Table 4. Output Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.351[a]	.123	.097	14.22566

Based on Table 4, the coefficient of determination (R Square) is 0.123, which means that the influence of the independent variable (learning motivation) on the dependent variable (learning outcomes) is 12.3%. Other factors influence the rest.

Students' Responses

Students fill out a response questionnaire consisting of 16 statements related to learning using Android-based interactive multimedia, and the proportion is 81.25%, with an excellent response category. Aspects of the display, learning video features, learning evaluations, and especially diagnostic tests as innovations can guide students to recognize their knowledge and recognize students in each category about the feedback presented at the end of the evaluation.

4 Conclusion

Some of the research conclusions reached based on the formulation of the problem, objectives, results, and discussion of the research, namely as follows: (1) The learning results of students learning with Android-based interactive media improved in a secondary school in Medan, which received an average gain of N 0.66 and was rated in the middle category; (2) There is an influence between learning motivation and student learning outcomes 12.3%; (3) Student responses to interactive media based on Android development scores were 81.25%, with a good response category.

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