Gamification for Learning Media: Learning Chemistry with Games Based on Smartphone

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Abstract. This research aims to determine the effectiveness of smartphone-based games as a media for learning chemistry, especially hydrocarbons. The effectiveness obtained from the activities of learners, learner questionnaire, learning outcomes, power retention of the learning outcomes of students, and motivation questionnaire. The study was conducted at a high school in East Java Indonesia with one experimental class and one control class. The results of the study showed the activities of the students 90.47%, the student questionnaire 85.5% - 98.2%, learning outcomes achieve classical mastery 86.6%, the retention power of learning outcomes in the excellent category, and the student motivation questionnaire gave a percentage of 88.89% to 93.33%. Based on the results, then the game is based smartphone effectively used as a media of learning chemistry on hydrocarbon material. The advantages gained in a game that is able to eliminate the boredom learners when studying chemistry and makes power retention of the results of learning is high.

Keywords: gamification, learning media, smartphone games, hydrocarbons.

1. Introduction

The development of information technology that is increase rapidly in the current era of globalization is inevitably affecting the world of education. The global demand requires the world of education to always and constantly adjust technological developments to improve the quality of education, especially the adjustment of information and communication technology for the world of education, especially in the learning process. The trend of education in Indonesia in the future is the use of interactive information technology tools [1].

One of the learning principles that use information technology to improve the efficiency and effectiveness of learning. The principle of learning that uses information technology allows learning activities to be more effective, so in the learning process it is necessary to utilize information technology as a learning media. Learning pursue based on the characteristics of the activity fun, challenging and motivating learners to actively participate [17]. The active role of students occurs if they are involved in the learning process directly. Chemistry learning materials in high schools have many concepts that are quite difficult to understand by students because they have the characteristics of being abstract, simplifying from the actual situation, sequential and tiered [2]. One important concept taught in chemistry is hydrocarbons.

Based on preliminary data before research conducted at two schools in East Java - Indonesia, learners assume that chemistry is one of the subjects that are difficult and unattractive. One of the factors that cause chemistry is not interesting is the learning process that is often used in the study of limited chemistry with a whiteboard, LCD projector, and textbooks. The above data indicate the development of technologies such as smartphones have not used it optimally in the education system at both schools stretcher, the data of teachers of chemistry found that learners can not be given back to the material being studied previously whereas as a prerequisite material next lesson and should be repeated and that this requires additional time.
The reason given by students, that the learning process is not interesting and tends to be boring makes students not pay attention to learning in class, but if the hydrocarbon material is taught with a pleasant situation and challenges students to build their own knowledge then students will actively participate in direct learning process [16]. An unattractive learning atmosphere can be handled by using creative media [3].

One effort that can be done by making technology-based learning media that can be fun, challenging, and motivate students, and has good retention, one of them is game as learning media [4]. Game can integrate between fun with learning and to motivate learners to learn science [5]. The game can give its own impression in the memory of students and provide a pleasant learning atmosphere without leaving the learning objectives.

Aside from being a learning medium, games can practice problem solving skills. Application of games improve learners' interest in learning, speed of information processing, problem solving, increase social sensitivity and a certain ability to resolve the question on the application referred to as an application gamification [6]. Therefore gamification has great potential to be used as a learning media.

Gamification for learning media is a game specifically designed to teach a particular learning, development of concepts and understanding and guide them in practicing their abilities, as well as motivating them to play [7]. Or a game which components utilized to education better known as gamification. One of the main tools that support learning with gamification is smartphone. Smartphone is a tool that is very suitable to be used as an experiment because it is equipped with various sensors [8]. Smartphones can be used as a means of learning chemistry because most students have them and have an advantage over laptops.

Based on the explanation above, it takes a game as a media of learning that can improve the learning outcomes of students, especially in the hydrocarbon material and can provide a solution that is better in order to facilitate subsequent learning teaching materials. Then research on the effectiveness of games that contains tournaments, materials, and questions related to hydrocarbons is needed. Gamification as a learning media is expected to be a choice of chemical learning media, especially Hydrocarbons to make learning fun, improve learning outcomes, high retention of learning outcomes, and can be a means of learning for students in the learning process in the classroom or outside the classroom.

2. Method
The method used system pretest-posttest control group design conducted against participants of students at a high school Jombang East Java - Indonesia, used games has met the eligibility as a medium of learning [16] and design research as follows.

\[ O_1 \xrightarrow{X_1} O_2 \xrightarrow{X_2} O_3 \] experimental group

\[ O_1 \xrightarrow{X_2} O_2 \xrightarrow{X_1} O_3 \] control group

Both groups prior to learning were performed pretest (O₁) and after learning were given posttest-1 (O₂), after seven (7) days posttest-1 was conducted posttest-2. The experimental class conducted learning using games as a learning medium (X₁), while the learning control class without using games (X₂). In the experimental group during learning the observations of the students' activities were carried out and after the questionnaire learning was done.

Student learning outcomes in the form of posttest-1 and posttest-2 are used to determine the completeness of learning outcomes and the retention power of student learning outcomes. Individual learning completeness is set with a greater score of 78 in accordance with school regulations and classical completeness is set to be greater than 85%.
Participants’ motivation in education can be measured by referring to the ARCS model (Attention, Relevance, Confidence, and Satisfaction). The results of the students' learning motivation questionnaire are calculated using the process. The game is said to be effective if it gets a greater percentage equal to 61% with good criteria.

3. Results and Discussion

3.1 Observation Results of Student Activities
Observation of the activities of the experimental class students was done in groups by four observers. Each group consists of three students which means that each observer makes 2-3 observations to 10 groups. Participants learners have used the game very well evidenced by the percentage of the activity of 90.47% with a very good category.

3.2 Results Questionnaire Student Response
After participating in learning by using the game as a learning media, students are given a questionnaire response to find out the response to the game. The following are the results of the questionnaire responses given to students.

| Assessed Indicator                                      | Percentage of Answers (%) |
|--------------------------------------------------------|----------------------------|
| Student interest in the game                           | 93.3                       |
| Updated game                                           | 93.3                       |
| The usefulness of the game                             | 98.2                       |
| Ease of understanding the material and use of the game  | 95.7                       |
| **Language in the game**                               | **85.5**                   |

Based on Table 1, the percentage of all aspects of the questionnaire responses of students between 85.5% to 98.2%, which means that almost all students can use the game well. This is because the game as a learning medium is fun, combining learning to play chilli so students feel happy when learning. The game is something fun and entertaining [9]. From the results of the questionnaire responses to aspects of interest in the game as a learning media get a percentage of answers of 93.3% which shows that overall students are interested in using the game as a learning media. Games make students excited and interested in learning chemistry, especially on hydrocarbons, they like learning chemistry using games and they want to re-learn chemistry using games, it is an indicator that shows their interest in games that are used as learning media. A smartphone-powered game that displays an interesting gameplay and multimedia makes students interested in playing it so that they can finally learn chemistry from the games they have played [10]. Meanwhile, the assessment indicators that obtain the next high percentage are the ease of understanding material and its use by 95.7%. This means the game makes students understand the chemical material and makes it easier for them to do the posttest, the game is easy to operate, the menus in the game function well and the instructions in the game are not difficult to understand are indicators that indicate if the game makes it easy for students to understand the material and easy to operate. The results of this response indicate the use of smartphone games received positive responses by students.

3.3 Student Learning Outcomes
Student learning outcomes data obtained through the provision of pretest and posttest sheets. To measure the retention of learning outcomes conducted posttest-2 after seven days of posttest-1 implementation. Score pretest, posttest-1, and posttest-2 are presented in Table 2 below.
Table 2. Results pretest and posttest experimental group

| Score   | Sum students | Means | Completeness | Sig  | t count | t table | df |
|---------|--------------|-------|--------------|------|---------|---------|----|
| Pretest | 30           | 22.61 | 0.0%         | 0.74 | -25.52  | 2.045   | 29 |
| Posttest-1 | 30       | 83.14 | 86.6%        | 0.57 |         |         |    |
| Posttest-2 | 30       | 75.10 | 76.6%        | 0.08 |         |         |    |

Based on Table 2, pretest scores did not reach completeness while at posttest-1 score shows the gain completeness 86.6% and have reached the specified classical completeness. When examined Kolmogorov-Smirnov normality test on the pretest score and sig posttest-1 score, obtaining sig respectively 0.74 and 0.57, showing greater than 0.05 means that the pretest and posttest scores were normally distributed so that paired t test can be done [11]. The calculation results with the help of the SPSS program obtained the price of t arithmetic of -25.52 when compared with the price of t table (df = 29, α = 5%), it turns out t arithmetic is greater than the price of t table so that Ho is processed means that there is a significant difference between the pretest scores and posttest-1 score. This shows the chemistry learning subject matter of hydrocarbons has achieved success by using games as a learning media. The following are the results of the control group learning.

Based on Table 3, pretest scores did not achieve completeness, while posttest-1 score showed 37.9% completeness and no established classical completeness.

Table 3. Results pretest and posttest control group

| Score   | Sum students | Means | Completeness | Sig  | t count | t table | df |
|---------|--------------|-------|--------------|------|---------|---------|----|
| Pretest | 29           | 22.60 | 0.0%         | 0.70 | -28.07  | 2.048   | 28 |
| Posttest-1 | 29       | 72.23 | 37.9%        | 0.81 |         |         |    |
| Posttest-2 | 29       | 52.23 | 0.0%         | 0.66 |         |         |    |

When examined the Kolmogorov-Smirnov normality test on the pretest score and sig posttest-1 score, obtaining sig respectively 0.70 and 0.81, indicating greater than 0.05 means that the pretest and posttest scores were normally distributed so that paired t tests can be performed [11]. The results of calculations with the help of the SPSS program obtained t count of -28.07 when compared to the price of t table of 2.048 (df = 29, α = 5%), it turns out t arithmetic is greater than the price of t table so that Ho is processed means that there is a significant difference between scores pretest and posttest-1 score. This shows the chemistry learning subject matter of hydrocarbons has occurred a significant difference but did not reach the specified classical completeness, so it can be said that learning is not successful when learning without using games as learning media.

Although there were still errors in the posttest-1 in the experimental class, the increase in classical completeness was very good, from 0.0% to 86.6%. This means the influence of the game included in the category is very good for achieving the target completeness. When compared with the control class a classical increase in completeness is 0% to 37.9%, but these results have not reached the specified target.

To determine the retention of students’ learning outcomes presented a comparison of the experimental and control class retention power can be presented in Table 4 below.

Table 4. Comparison of the retention power of the experimental and control classes

| Group   | Means Posttest-1 | Means Posttest-2 | High retention power | Medium retention power | Low retention power |
|---------|------------------|------------------|-----------------------|------------------------|---------------------|
| Experiment | 83.14            | 75.10            | 96.6%                 | 3.4%                   | 0%                  |
| Control  | 72.23            | 52.23            | 58.63%                | 34.48%                 | 6.89%               |
Table 4 shows the posttest-1 and posttest-2 scores between the experimental class and the control class related to the retention of learning outcomes. In the experimental class showed good retention, because students who received a high level of retention reached 96.6% while in the control class showed less retention because students who gained high retention reached 58.63%. This can be interpreted, learning by using games can create retention power of good students, meaning that the game of student retention power is better than learning without using games as learning media [12]. This evidence will be very useful for chemistry teachers who will learn a learning material and require prerequisite material beforehand.

3.4 Results of Student Motivation Questionnaire
The results of student motivation questionnaires after using games as a Hydrocarbon learning media are presented in Table 5.

| Table 5. Motivation Questionnaire Results |
|------------------------------------------|
| Assessed Indicator | Averages |
|---------------------|----------|
| Attention           | 91.11%   |
| Relevance           | 92.22%   |
| Confidence          | 93.33%   |
| Satisfaction        | 88.89%   |

Based on Table 5 the results of student motivation questionnaire get an average percentage of 91.39% which is included in the excellent category. In other words the game can make students have a high level of motivation to learn and also have an ongoing motivation to learn. This is evidenced by the acquisition of a percentage of 91.11% in the aspect of attention, 92.22% in the aspect of relevance, 93.33% in the aspect of confidence, and obtained a percentage of 88.89% in the aspect of satisfaction.

Relevance in learning needs to be built because attention and curiosity are conditions in building motivation [13]. Therefore it is important for students to understand the requirements in learning so that consistency with the initial goal has clear objectives which are a key component of relevance. Confidence is needed to build motivation [14]. Self-confidence can be achieved by helping students set positive expectations for success, so that students can work with their own abilities rather than relying on luck to achieve success. The advantage of the game is that it can motivate students to develop and increase their level of learning [15]. In learning, motivation can act as a driver of learning activities in students so that the goals to be achieved by students can be achieved. By utilizing the advantages of the game, the game can be used as a learning medium so that the game can create during the learning of active students and even make learning centered on students, provide better learning outcomes, students feel they can eliminate the boring atmosphere, and provide good retention power, and can motivate students.

4. Conclusions and Suggestions
4.1 Conclusions
1. The use of gamification as a learning medium can achieve high effectiveness in hydrocarbon learning based on student activities, student responses, learning outcomes, retention power of learning outcomes, and student learning motivation.
2. Smartphone-based games are preferred by students as learning media because wherever students are always carrying them so they can be used to learn inside and outside of school.

4.2 Suggestions
Chemistry teacher should utilize games that have been proven to be suitable as learning media so that they can function as learning media and can also entertain students when they feel bored.
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