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GAMIFICATION: GAME AS A MEDIUM FOR LEARNING CHEMISTRY TO MOTIVATE AND INCREASE RETENTION OF STUDENTS' LEARNING OUTCOMES

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Abstract

This study aims to obtain the game as a gamification in education that is appropriate to be used for hydrocarbon learning media based on the validity, practicality, and effectiveness of the game. The research method used is the research and development method, the study was conducted in East Java High School-Indonesia. Validity is obtained from the game assessment by the validator. Practicality is obtained from the questionnaire responses of students and observations of students' activities while using the game. The effectiveness is obtained from the learning outcomes of students, the results of students' learning motivation questionnaires, and student retention. Based on the results of the research, the game developed is named "Hydrocarbons Chem-Rush" is declared appropriate as a learning medium on hydrocarbon material. It has better learning outcomes than the control group, students are more motivated to continue playing and learning, students are active during learning, and it can make power of student retention very good.

Keywords – Chem-rush, Gamification for education, Learning media, Retention.

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1. Introduction

Computer-based games can challenge teachers to innovate when using gamification in their learning. The use of games for educational purposes can motivate students as a new generation that grows in the age of video games (Glover, 2013). It was also stated that the fun and excitement in the game provided great potential for educational applications (Cheng, She & Annetta, 2015). In the field of education, it has been stated that through gamification students can be motivated to learn in new ways or enjoy tedious assignments. One of the principles of learning is the use of information technology to improve the efficiency and effectiveness of learning. The use of technology as a learning medium can help in increasing students' learning motivation. Apart from the function of the media to convey information

from teachers to students, it can also attract students' interest to actively participate in the learning process, so that students' learning motivation can increase (Sánchez-Mena & Martí-Parreño, 2017). Motivation to learn as an initial capital that can help learning success and as an effort for good student retention power, retention is the ability of students to save the results of efforts to obtain an intelligence and abilities that can still be displayed by students after an interval of a certain period of time and can be expressed again by students (Lubis & Simatupang, 2014; Ibáñez, Di-Serio, & Delgado-Kloos, 2014), or in other words that student retention or student memory is the ability that exists in students to receive, enter information, bring back things that were previously obtained.

Hydrocarbon material is one of the materials in Chemistry that studies about compounds composed of carbon and hydrogen atoms. Based on the results of the pre-research conducted with 105 students in two schools, 71.4% of students stated that hydrocarbon material was material that was difficult to study. The difficulty of students in hydrocarbon material lies in the sub-material reaction of hydrocarbon compounds, the structure and nomenclature of hydrocarbons, and the peculiarities of carbon atoms. This is because students still lack understanding related to the concept of reaction mechanism, students do not remember or forget about relevant material even though they have learned it, such as electron configuration, Lewis structure, and chemical bonds. Students often forget and skip the steps for naming hydrocarbons based on IUPAC.

Based on the results of interviews with two Chemistry teachers, the Chemistry learning process that has been applied at school occasionally shows phenomena related to the material through video media or power points. The difficulty of the teacher during teaching Chemistry is to create a learning atmosphere that attracts the attention of students, also said that hydrocarbon material is material that is not difficult to learn by students, but there are still students whose learning outcomes have not reached the standard of mastery learning and learning retention power is still low. This is likely because students are still less enthusiastic and less motivated in learning.

One of the things that can be used to increase students' learning motivation is to create a pleasant learning atmosphere. Based on this, one of the things that can be done is to create a media that can make a pleasant learning atmosphere, arouse learning motivation, enthusiasm, and improve student learning outcomes. Interactive media that can be used as learning media is games (Andiastutik & Lutfi, 2017). Games as learning media can help students learn independently and create a creative atmosphere for students, so the learning process is more interesting (Smaldino, Lowther & Clif, 2019). The interest of students with android-based games obtained data that all students have played through their mobile phones, the frequency distribution of students playing is presented in Figure 1.

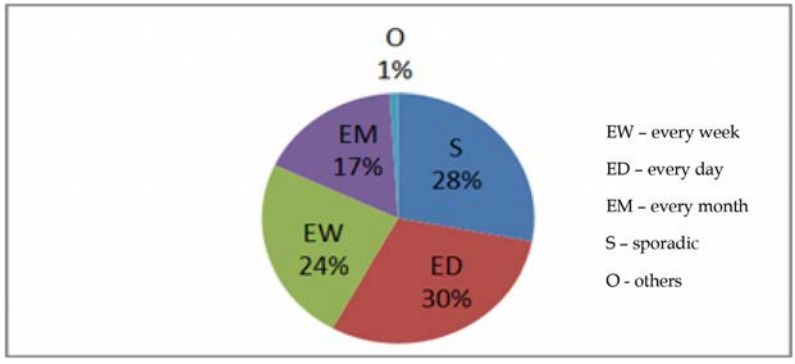

Figure 1. The frequency of students play

There is a number of games used as learning media. One of which is the result of Andiastutik and Lutfi's research (2017) named the Personal Computer (PC) based Diamond Chemistry Adventure game which is adventure type and endless run. The developed game can be used offline on a PC or laptop. The game is used for the learning process on hydrocarbon material, but the material presented in the game is only in

the form of text and still does not optimize the advantages of ICT, so some students still feel bored. In addition, the material presented in the game does not have to be read by users/players, so it has not yet reached optimal results as a medium of learning.

Based on preliminary studies, it is necessary to play games that can complement the deficiencies found in hydrocarbon games that were previously available. The game that is more flexible to use, considering that currently in playing most game users choose to use mobile phones. The game developed will also present material in the form of text and video to reduce the level of saturation of students in playing. The game needed is an endless run type adventure game with a laboratory theme. This game focuses on hydrocarbon materials that can be used on Android smartphones and named Hydrocarbons Chem-Rush. At the beginning of the game, the player will determine the character that will be used namely Prof. Chemi or Prof. Stry. Then the player must watch the video material first. It is intended that students have the material and a little more understanding of hydrocarbon material before playing so that they will be better prepared when they have to answer game questions and can be utilized when having difficulty playing. Then the chosen character will run to collect a number of colorful Erlenmeyer flasks and pass obstacles. At each level of the game there will be different challenges. This game will invite players to solve the available questions so they can continue the game and go to the next level. Figure 2 shows examples of some game appearances used.

Figure 2. The Hydrocarbons Chem-Rush game design. A. Game homepage.
B. Available characters. C. Game rules. D. Score appearance

The purpose of this research is to get a Hydrocarbons Chem-Rush game that is suitable as a hydrocarbon learning medium and has its advantages. The use of this game is expected to make students more interested, improve student learning outcomes, especially on hydrocarbon material, help the process of learning hydrocarbons, can be a learning medium that is easy to use, and student retention (retention rate) learning outcomes are good, and can motivate learners to study. Therefore, the framework of game development as a game media must have a close relationship between learning material and game design (Rosyid, Palmerlee & Chen, 2018). Games that are developed as learning media must not only meet the requirements of the game, but must meet the requirements as learning media, and meet the pedagogical aspects (Lutfi, 2017).

2. Method

The research method carried out in the development of the Hydrocarbons Chem-Rush game is a research and development (R & D) method. Broadly speaking, this research and development step consists of three steps, namely 1) Preliminary Study, 2) Product Development, and 3) Testing (Sukmadinata, 2016). This research was carried out at the testing stage, especially at the game trial step in one experimental class. Obtaining a decent game as a learning medium in terms of aspects of validity, practicality and effectiveness (Nieveen& Folmer, 2013). The validity of the game is obtained from the validator's assessment, practicality is obtained from the response of students who are supported by observations of students' activities, while the effectiveness of the game is obtained from the results of learning and student learning motivation questionnaire. In the trial, two classes were used, namely the experimental class and the control class in which pretest and posttest were conducted. Observation of students' activities during learning and motivation questionnaires were given to students of the experimental group. The delay test (posttest) was carried out again after ten days of the posttest to determine the retention (storage) of the learning outcomes, the posttest results were compared between the control group and the experimental group, the calculation was done using SPSS program assistance, along with the stages in the study.

2.1. Preliminary Study

Preliminary study is the initial stage of preparation for development, this stage consists of three steps, namely literature study, field surveys, and game design planning. Literature study examines concepts and theories related to learning using games, students' characteristics, and studying relevant previous research results. Field surveys, conducted through interviews with chemistry teachers and giving questionnaires to students. Teacher interview is to find out the teacher's skills in developing hydrocarbon learning media, learning resources, students' learning motivation, and learning implementation. The next step is to draft a game product that includes activities: determining the name of the game, developing learning objectives, making a storyboard that serves to explain the storyline to facilitate the making of the game.

2.2. Product Development

After the game draft is finished, a review is carried out by experts which include game review activities, game improvement, and game validation. The game review is conducted by material experts and media experts to obtain suggestions and input. Suggestions and feedback received are used to improve the game before entering the game validation step. Validation was carried out by three experts, using calculations from the Likert scale, that is: 0 (there are no components), 1 (very less once), 2 (less so), 3 (Less), 4 (good), and 5 (very good). The validity assessment results are calculated using the following formula.

$$\text{Validity (\%)} = \frac{\sum \text{score of each indicator } 100\%}{\sum \text{criterion score}}$$

$$\text{Criterion score} = \text{highest score} \times \text{number of validators}$$

The calculation results are then interpreted as in the following table (Riduwan, 2015).

Score (%)	Criteria
0-20	Very Invalid
21-40	Invalid
41-60	Valid enough
61-80	Valid
81-100	Very Valid

Table 1. Criteria for interpretation of scores

The Hydrocarbons Chem-Rush game is said to be valid if it reaches a percentage score ≥ 61% with a valid to very valid category (Riduwan, 2015). If the game does not meet the criteria, then repairs are made to perfect the game, after that it is reassessed until it reaches valid criteria.

2.3. Testing

During the development phase, students were tested at two of the high schools in East Java, Indonesia, to obtain data related to the practicality and effectiveness of the game. The trial was conducted using pretest-posttest control group design, the determination of the experimental class and the control class was carried out randomly. In both groups before learning students are given a Pretest sheet to find out the students' initial abilities about chemicals, especially hydrocarbons. Then the experimental group students followed the learning by using the Hydrocarbons Chem-Rush game as a learning medium. After learning, each student in the two groups was given a Posttest 1 sheet, which contained hydrocarbon questions in accordance with the learning objectives consisting of choice questions and description questions, as well as student learning motivation questionnaires, also a delay test (posttest 2) conducted ten days after the posttest 1 was used to determine power student retention. The trial design can be presented in the following diagram.

Experiment group	$O_1 \rightarrow O_2 \rightarrow O_3$
	X_1
Control group	$O_1 \rightarrow O_2 \rightarrow O_3$
	X_2

Explanation

X_1 – Learning by using games	O_1 – Pretest
X_2 – Learning without using games	O_2 – Posttest 1
	O_3 – Posttest 2

2.3.1. Practicality

Questionnaire about using games as learning media were given after learning. The results of the questionnaire were used to determine the practicality of the game, calculated using the following formula.

$$\text{Practicality (\%)} = \frac{\text{The total score of each statement}}{\text{maximum number of score}} \times 100\%$$

The Hydrocarbons Chem-Rush game is said to be practical if it gets a percentage of students' responses of ≥ 61% (Riduwan, 2015). During learning to use the game Hydrocarbons Chem-Rush observers observed the activities of students. The results of the observation of the activity aim to photograph the activities of students during learning by using games and used to support practicality data, the following formula is used (Winarsunu, 2009).

$$P\ (\%) = \frac{\sum Xi}{\sum X} x\ 100\%$$

Noted,

P = percentage of student activity

∑Xi = number of observations on observed aspects

∑X = the maximum number of observations in each aspect

2.3.2. Effectivity

Effectiveness is based on the level of student motivation, learning outcomes, and student retention. The results of students' learning motivation questionnaires are calculated using the following formula.

$$\text{Effectivity} = \frac{\text{Number of scores Obtained}}{\text{Maximum number of scores}} \times 100\%$$

Student learning outcomes are used to determine the effectiveness of the game in terms of mastery learning, improvement of student learning outcomes, and student retention power.

Mastery learning is calculated through individual completeness using the following formula.

$$\text{Individual completeness} = \frac{\text{Individual score}}{\text{Total score}} \times 100\%$$

Students are said to be complete individually if the minimum score obtained reaches 78 in accordance with the provisions in the school. Then the classical completeness calculation is done using the following formula.

$$\text{Classical completeness} = \frac{\sum \text{student of individual completeness}}{\sum \text{total of students}} \times 100\%$$

Analysis of students learning outcomes improvement scores was performed paired t test and independent t test of the experimental group and the control group.

$$\text{Retention power is calculated by the formula (R)} = \frac{\text{Posttest score 2}}{\text{Posttest score 1}} \times 100\%$$

From the formula above, if the R value is smaller or equal to 60%, then the retention power falls into the low retention category. If the R value is in the range of 60% - 70%, then the retention power is in the medium retention category, and the R value is greater than 70%, then the retention power is in the high category. The Hydrocarbons Chem-Rush game is said to be effective if the learning outcomes of students have a significant difference between the pretest score and the posttest score, the achievement of classical completeness on the posttest score of at least 80%, and the number of students who achieve moderate and high retention power is greater than 60% minimum by 80%. To motivate students to learn effective if it gets a percentage of $\geq$ 85%.

3. Research and Discussion Results

Following are the results of the research carried out along with the discussion.

3.1. Preliminary Study

The function of learning media not only to convey information from teachers to students but also attract students' interest to actively participate in the learning process so that learning motivation can increase. Learning theory that supports the use of games as a learning media is the theory of behaviorism according to Skinner. Skinner states that learning is a change in behavior due to the presence of repetitive responses. The next theory is the theory of constructivism according to Vygotsky, Vigotsky argues that scientific understanding does not come in the form of what happens to a student. Gradually, assistance will be provided so that students are able to learn independently (Slavin, 2009). In addition, there is a theory of information processing, namely cognitive theory of learning that explains the processing, storage, and recall of knowledge from the brain (Ibrahim & Nur, 2004).

The results of literature studies related to previous research on the use of games in the learning process, the results obtained that the use of games can provide motivation and student retention of learning. Games can improve students' understanding (Bintiningtiyas & Lutfi, 2016). Games that are designed for

the medium of learning natural science, meet the required components, namely: the truth of the content, meet the rules of the game, meet the requirements of learning media, in accordance with the pedagogy, and meet the supporting facilities used (Lutfi, 2017). Based on the description above, it is necessary to develop games as learning media on hydrocarbon chemical materials which are expected to create a pleasant learning atmosphere, achieve learning goals, generate learning motivation and achieve good student retention power.

3.2. Product Development

Preparation of product drafts began with the compilation of game designs in the form of storyboards and game manuals that refer to the assessment components including the game requirements component, pedagogic components, and components as learning media. Basic Competencies are taken based on the applicable curriculum and basic competencies indicators as well as learning objectives are prepared. The storyboard that has been completed is realized in the form of a game with the Construct 3 program. The Hydrocarbons Chem-Rush game that was completed was then reviewed by experts and validated by validator. Table 2 shows the validation results and their explanation.

Aspect	Rating Indicator	Validity (%)
Content Validity		
Truth concept	The concept of hydrocarbon material in the game is correct	80
Material suitability	Material in the game according to indicators and objectives	86.67
Construct Validity		
Chemical aspects	Practice basic science process skills in the form of watching (watching videos) and classifying (kinds of hydrocarbons)	73.33
	Analyze the concept of hydrocarbons with game problems	80
	Knowing the steps for naming a hydrocarbon compound based on IUPAC and applying it	93.33
Conformity with the characteristics of students	In accordance with students' learning styles	80
	According to the age of the students	86.67
Rule of the game	There are guidelines or rules of the game that are understood	86.67
Guiding	There is material before the game starts	86.67
Requirements, obstacles and strategies for playing	There are requirements in playing to make it more challenging for students to play	80.00
	Encourage the process of setting strategy in play so that players can avoid obstacles and not run out of lives	80.00
Give feedback	There is a penalty for failure	93.33
	There is a prize for success	86.67
Display the game as a learning media	The colors used in accordance with the background being used	86.67
	Font size used	86.67
	Animation is used in accordance with the chemical content	86.67
Language quality	Use good and correct Indonesian	86.67
Software engineering	Media programs are easy to manage / maintain (maintainable)	86.67
	The program is easy to use and operate (usability)	80.00
	Ease installed on the device (compatible)	86.67
Audio visual communication	There is an attraction between narratives, sound effect, back sound, and music	80.00
	There is harmony between the background design and the placement of text and color.	86.67

Table 2. Results of content validity

The assessment indicators on content validity scored 80% and 86.8%, indicating that chemical concepts, especially Hydrocarbons, are in accordance with the substance and applicable curriculum and the material is in accordance with the learning objectives. Learning concept is one of the learning objectives (Dahar, 2001) and the use of games as learning media is used so that students can easily remember what they have learned (Hamdani, 2011). These results indicate that the material and questions in the game are in accordance with the learning objectives.

There are three assessment indicators in the chemical aspect. Each indicator obtained a score of 73.33%, 80.00%, and 93.33% meaning it has met the valid category. The aspect of conformity with the characteristics of students has shown a valid category. This means that it has fulfilled that learning media will help learning activities occur (Sadiman, 2010) and students will be able to rely more on their own cognitive strategies in utilizing available learning resources (Smaldino et al., 2019).

As a learning medium, the game has game rules and it is guiding. Both aspects get a very valid category score. This shows that the validator assesses that the game has good rules and it is in accordance with the opinion of Lutfi, Hidayah, Sukarmin and Dwiningsih (2021), that the game must have clear rules for students (players) so that the game can act as a learning medium. Moreover, it is in accordance with the concept of constructivism learning that students are controlled to learn in the form of discovery guidance which allows students to make decisions about learning goals (Hamdani, 2011). In addition, by using this game, students must take the initiative to interact with other students or teacher because learning can be controlled by the students themselves.

The fifth and sixth aspects show valid and very valid categories, meaning the game has game requirements and can provide excellent feedback. This is in accordance with Sadiman (2010) who states that the game has the advantage that it can provide direct feedback. Prompt feedback on the players who do it will allow the learning process to be more effective and it is in accordance with Lutfi, Aftinia and Ipmawati's (2021) statement in choosing games as learning media namely the attractiveness to students.

In the aspect of game display and software engineering, the score is valid and very valid, this aspect greatly affects the attractiveness of the Hydrocarbons Chem-Rush game developed. This is because according to Hamdani (2011) in choosing games as learning media is attractiveness to students. These results indicate that the media can be used anywhere with the equipment in the vicinity and at any time and is easy to move.

The last aspect consists of two assessment indicators, namely "There is a relationship between narration, sound effects, background, and music" and "There is harmony between the background design and the placement of text and colors". Both of them consecutively obtained percentages with valid and very valid categories.

Based on the aforementioned explanation, the Chem-Rush Hydrocarbons game obtained a percentage of validity with a range of 73.33% - 93.33%. This means that the game Hydrocarbons Chem-Rush is valid or has reached the standard for use as a learning medium for hydrocarbons.

3.3. Testing

This research was carried out only until the trial phase. Game trials were conducted in one class as an experimental group and one class as a control group. The trial was conducted aiming to determine the effectiveness and practicality of the Hydrocarbons Chem-rush game. The practicality of the game is seen from the results of students' responses to the game and the results of observations of students' activities during learning by using games as a learning medium. The effectiveness of the game is based on student learning outcomes, learning motivation questionnaire results, and student retention. The control group is used to compare with the experimental group on the learning outcomes of students and their ability, the data obtained in the trial activities are described as follows.

3.3.1. Questionnaire Results of Students' Response

After using the Hydrocarbons Chem-Rush game as a learning medium, students are given a questionnaire response to find out the response to the game as a learning medium. The following results from the response questionnaire given to students.

Assessed Indicator	Percentage of Practicality
Interest in games as learning media	96.67%
Game update	98.00%
The usefulness of the game	85.33%
Ease of use of the game	83.20%
Linguistic	100.00%

Table 3. Questionnaire response results

The percentage results show that the level of student interest in the Hydrocarbons Chem-Rush game is very high with a percentage of 96.67%. Gamification for the game is very interesting because the player must learn what is needed to overcome the problems and finally solve the game. Berlyne and Kopp in Keller also explained the importance of combining various strategies to get students' attention such as by using attractive graphics, animations, or all kinds of events that cause conflict (Keller & Katsuaki, 2004).

Based on the results of the questionnaire responses of students showed that the level of novelty of the game developed by researchers is very high, obtaining a percentage of 98%. The usefulness aspect of the game obtained an average percentage of 85.33% which is in the very good category. The proper and varied use of educational media can overcome the passive attitudes of students. The ease-of-use aspect of the game obtained an average percentage of 83.2% with very good criteria. The average percentage is rather low because there are few bugs or errors when the game is used. Based on the explanation above it can be seen that the level of ease of use of the game is quite high.

In the linguistic aspect, an average percentage of 100% is obtained. This is supported by the results of the percentage of the questionnaire responses that 100% of students stated that the language used in the game is Indonesian that is easily understood. The language used in the game must use good and correct Indonesian so that students or game users can easily understand the meaning of the game. Based on the explanation above, the Hydrocarbons Chem-Rush game obtained a practical percentage on average of 91.06%. This means that the Hydrocarbons Chem-Rush game reaches a very practical category used as a learning media.

3.3.2. Observation Results of Students' Activities

The observations of the students' activities were carried out by 3 observers in the experimental class. Observed student activities are the dominant activities carried out every 2-3 students at any given time span during the use of the Hydrocarbons Chem-Rush game using the student observation sheet. The results of observations of students' activities are used to support the results of students' questionnaire responses. The results of observations of student activities obtained an average percentage of 88.45%. The percentage results show that the Hydrocarbons Chem-Rush game is included in the excellent category as a learning medium on hydrocarbon material. This means that students have very good activity in using the Hydrocarbons Chem-Rush game during learning.

In each part of the activity observed, the percentage varies. There are several parts to the activity that must occur. These activity points include (1) Students focus their attention when using the Hydrocarbons Chem-Rush game, (2) Students can use the menu and game buttons properly, (3) Students read the manual / rules of the game, (4) There was no error in the game, (5) Students read hydrocarbon material in the game, and (6) Students did not complain and did not feel bored while using the game. All aspects get a

percentage of 100%, except for "Using buttons and menus well" which gets a percentage of 83.33%. These results support the questionnaire responses of students that is 80% said the menus and buttons on the game can be used properly. This means that around 19-20 students out of 25 students have been able to operate each menu and game button well. In the "There are no errors in the game" percentage get 75%. These results are in accordance with the results of the questionnaire responses of students namely 76% stated there were no errors in the game. These two parts show that the Hydrocarbons Chem-Rush game is easy for students to use.

Another activity that is "Students don't ask how to operate the game" gets a percentage of 75%. This means that 75% of students can operate the game simply by reading the game manual without asking. There are still students who ask how to operate the game because students do not understand the contents of the game manual that has been given previously, meaning that there are still manuals that are not understood by students. In the activity section "Students express questions during learning" and "Students are not sleepy and do not speak out of context during learning" get a percentage of 75%. The use of appropriate and varied educational media can build students' passive attitudes. In this case the learning media is useful for (a) Generating the excitement of learning, (b) Allowing more direct interaction between students with the environment and reality, and (c) Enabling students to learn on their own according to their ability of interest (Smaldino et al., 2019).

Based on the explanation above the game developed can be said to be very practical to be used as a learning medium because it obtains an average percentage of practicality of 88.45%. These results are consistent with the opinion that applying gamification techniques in the curriculum can help provide more inclusive activities through their influence on students' sense of competition, interaction, and motivation (Chen, Liu & Shou, 2018; Byusa, Kampire & Mwesigye, 2020).

3.3.3. Students' Learning Outcomes

Student learning outcomes obtained from the results of the pretest and posttest in the form of written tests. The test is done by giving questions in the form of multiple-choice questions and description questions to the experimental group and the control group. Pretest is given before and posttest is given after learning, data on the results of the pretest and posttest are presented in Table 4.

Test Activity	∑ Students		Score Average		Completeness		Sig		t Count Pair	
	Exp	Control	Exp	Control	Exp	Control	Exp	Control	Exp	Control
Pretest	25	28	38,24	27.81	0%	0%	0.594	0.521	-25.04	-23.02
Posttest 1	25	28	80,92	71.93	88%	22.22%	0.152	0.366		

Table 4. Pretest and posttest 1 results of experiment and control groups

Based on Table 4 it can be stated that the score of the pretest and posttest in the experimental group increased, from the classical completeness from 0% to 88%, while the pretest and posttest score in the control group increased from 0% to 22.22% but the control group did not reach the classical completeness limit. Expected, which is greater than 80% (≥ 80%).

To test normality, it used the Kolmogorov-Smirnov Test with the help of the SPSS program. The Kolmogorov-Smirnov Test experimental group with a Sig on a pretest score of 0.594 and a sig posttest price of 0.152 are both greater than 0.05, meaning that the pretest and posttest scores are normally distributed. In the control group, sig pretest score was 0.521 and sig posttest score was 0.366, both of them were also greater than 0.05, which meant that they were normally distributed as well. The results of the normality test show that paired t test with pretest score and the similarity score of the experimental and control group posttest can be done.

In the experimental group, the t-test paired value of -25.04 is greater than the price of t table with df = 24, which is 2.06, so Ho is rejected, meaning that there is a significant difference between the average

pretest score and posttest score, while also classical completeness on posttest scores 88% has been fulfilled as expected. The t control price group in the paired t test of -23.02 is greater than the price of t table with df = 26, which is 2.05, so Ho is rejected, meaning that there is a difference in the average pretest score with the posttest score in the control group but the classical completeness only reaches 22,22% so that it is not expected.

Test the average score of the experimental group's posttest with the average score of the control group's posttest obtained t arithmetic = 4,487 with df = 50, t table of 2.00 means the price of t arithmetic is greater than the price of t table, so Ho is rejected. This means that there is a significant difference between the mean score of the experimental group posttest with the average score of the control group posttest and the score of the experimental group better. The results of the description above show that the experimental group and the control group each had a significant difference between the pretest score and the posttest score, but the control group did not achieve classical accuracy. This means that the use of games as a learning medium obtained better learning outcomes compared to learning without using games as learning media, these results are in accordance with the results of research Lin and Shih (2018) and Ibáñez et al. (2014).

These results are consistent with the results of research that states learning by using games as ICT-based learning media will increase the effectiveness of student learning when equipped with appropriate learning strategies (Hwang, Chiu & Chen, 2015). Besides, another statement that ICT-based games are increasingly regarded as a promising tool to motivate student learning. ICT-based games provide a learning environment designed where students can gain knowledge or skills from playing (Hwang et al., 2015). Rosyid et al. (2018) suggested that the material in the game that is adapted to the ability of players can facilitate effective learning experiences.

Furthermore, a comparison of the retention power of students in the two groups by comparing the posttest score with the delay score conducted 10 days after the posttest is presented in Table 5.

Score	∑ Students		Score Average		Completeness		Retention Power Exp	Retention Power Control
	Exp	Control	Exp	Control	Exp	Control		
Posttest 1	25	28	80.92	71.93	88.92%	22.22%	92%	50%
Posttest 2	25	28	81.00	65.7	84.00%	18.51%		

Table 5. Comparison results of posttest 1 and posttest 2 scores of the experimental group and the control group

The results of the analysis of student retention in the experimental group showed a price of 92%, meaning that the retention power of medium and high students reached 92%. It was even found that 1 student got a higher postponement score than the posttest score, this was possible because students were interested in trying to play again outside of learning. On the results of the analysis of student retention power in the control group showed a price of 50%, meaning that the retention power of medium and high categories reached 50%. Based on the description, it proves learning by using games as a learning medium for students to have higher retention power than without using games as a learning medium. In detail the retention power of students in both groups is presented in Figure 3.

Figure 3 shows the retention power of students using the game as a learning medium (experimental group) of the high category by 60% meaning that as many as 60% of students received a postponement score close to fixed with a posttest score conducted 10 days earlier, 32% of students who received the medium category, and as many as 8% low category. In learning without using games as a learning medium (control group) the retention power of high category students is only 14.3% and is dominated in the low category, which is 50%, meaning that the retention power of students is not good.

The results above indicate the power of student learning retention is better by using games as a learning medium compared to other media. These results are in accordance with the results of the study which states that learning in accordance with the characteristics of students will provide good retention power

(Lubis & Simatupang, 2014). Retention or memory has 3 (three) functions, including: (a) the function of inserting in stored memories are things that have been experienced by someone, (b) the function of saving, this second function is related to storage, the resulting problem is how can the learning that has been obtained can store properly, so that at a certain time can be generated again if needed, and (c) the function of giving rise again, this third function is related to re-creating things stored in memory, on recalling students can bring back what is remembered without the object (Caruth, 2018).

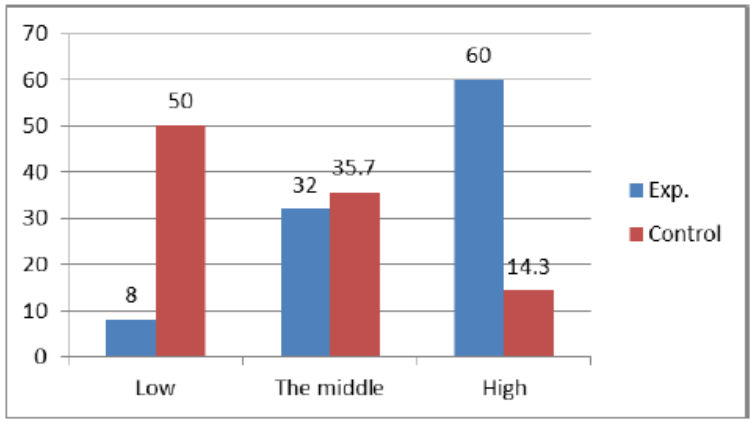

Figure 3. Experiment and control group of student retention power

3.3.4. Questionnaire Results of Students' Learning Motivation

Students' learning motivation is obtained based on the results of the motivation questionnaire given to students before and after learning using the Hydrocarbons Chem-Rush game in learning activities in the experimental group. The results of the motivation questionnaire after learning in the experimental group are presented in Table 6.

No.	Motivation Aspect	Percentage
1	Attention	80.8% - 90.4%
2	Relevance	76.0% - 79.2%
3	Confident	75.2 % - 84.8%
4	Satisfaction	84.0% - 89.6%

Table 6. Results of Students' Learning Motivation Questionnaires

The percentage of students' learning motivation after using the Hydrocarbons Chem-Rush game is in the range of 75.2% - 90.4% which is in the good to very good category. After using the Hydrocarbons Chem-Rush game in hydrocarbon learning, there is a high increase in students' learning motivation, 4%-17.6%. In this case it means that the Hydrocarbons Chem-Rush game can be used to motivate learners' learning. This result is quite interesting to be studied more deeply because motivation is the beginning of supporting students' success in achieving their goals. One of the strengths of the game is that it creates a pleasant atmosphere and increases students' learning motivation. This is consistent with research conducted by López-Carrillo, Calonge-García, Rodríguez-Laguna, Ros-Magan & Lebrón-Moreno (2019) which states that the advantages of the game are that it can motivate students to develop and improve student learning competencies. In addition, students in this case are no longer passive recipients of knowledge from their teachers but active knowledge builders (Watson, Mong & Harris, 2011), thereby achieving meaningful learning.

Android-based games are increasingly regarded as a promising tool for generating student motivation. And providing a learning environment can be designed so that students gain knowledge or skills from playing (Hwang et al., 2015). Many previous studies of gamification argue that by motivating students

through gift giving, their learning skills will be improved and ultimately improve their learning outcomes (Kim, Song, Lockee & Burton, 2018). To evaluate the advantages of the game as a learning medium, it has met the criteria of indicators on validity, practicality, and effectiveness.

4. Conclusions

Based on data analysis and discussion, conclusions can be given as follows.

1. The Hydrocarbons Chem-Rush game is appropriate to be used as a learning medium on Hydrocarbon material. This is based on fulfilling the feasibility aspects as a medium for learning hydrocarbons based on criteria of validity, practicality, and effectiveness.
2. The advantages of the Hydrocarbons Chem-Rush game as a learning medium:
    a) learning outcomes are better than control groups whose learning without using games as learning media,
    b) students are more motivated to keep playing and keep learning,
    c) student retention power is very good when learning chemistry using games as learning media compared to when learning without using games as learning media.

5. Suggestion

Gamification for learning media can be used as an alternative to chemistry learning, because high school students still like games according to their level, so games are needed that have fulfilled aspects of learning media, pedagogical aspects, and aspects of games. Therefore, the game developers should produce games that can be used by teacher as a medium for learning chemistry by paying attention to the pedagogical aspects.

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