Educación Química

House of Chemistry as a hydrocarbon learning media for high school students

House of Chemistry como medio de aprendizaje de hidrocarburos para estudiantes de secundaria

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Resumen

El propósito de este estudio fue evaluar el juego House of Chemistry como un medio de aprendizaje de Hidrocarburos capaz de mejorar la motivación de los estudiantes de secundaria. El estudio se realizó en estudiantes de secundaria en el este de Java, Indonesia, y se determinó aleatoriamente en dos clases, cada una como grupo de control y grupo experimental. Antes del aprendizaje se realiza la prueba inicial, luego se aprende de acuerdo al plan utilizando los medios disponibles en la clase para el grupo de control y el grupo experimental con el juego House of Chemistry como medio de aprendizaje, después del aprendizaje se realiza la prueba final, cuestionario de motivación y cuestionario de respuesta del estudiante. Los resultados de los datos obtenidos en el grupo experimental: (a) motivación de aprendizaje de los estudiantes del 94,5%; (b) puntajes en los resultados de aprendizaje de los estudiantes que logran la integridad clásica; hay un aumento en comparación con antes del aprendizaje; la puntuación de los resultados del aprendizaje es mejor que la puntuación de los resultados del aprendizaje del grupo de control; (c) las respuestas de los estudiantes obtuvieron el 90,6%; (d) existe una relación de 0,437 entre la motivación y las puntuaciones de los resultados de aprendizaje de los estudiantes. Se concluyó que el aprendizaje de hidrocarburos utilizando el juego House of Chemistry como medio de aprendizaje tuvo un impacto positivo en la motivación de aprendizaje de los estudiantes, hubo un aumento en los resultados de aprendizaje de los estudiantes y las puntuaciones de aprendizaje del grupo experimental fueron mejores que las puntuaciones de los grupos de control de los estudiantes dando respuestas positivas y correlación positiva entre la motivación y los resultados de aprendizaje de los estudiantes

Palabras clave

Química, completitud, casa de la química, medios de aprendizaje, motivación.

Abstract

The purpose of this study was to evaluate House of Chemistry game as a Hydrocarbon learning media able to enhance the motivation of high school students. The study was conducted on high school students in East Java Indonesia and determined randomly in two classes each as a control group and experimental group. Before learning is done the initial test then learning according to plan using the available media in the class for the control group and the experimental group with the game House of Chemistry as learning media, after the learning is done the final test, motivation questionnaire, and student response questionnaire. The results of the data obtained in the experimental group: (a) student learning motivation of 94.5%; (b) scores on student learning outcomes achieving classical completeness; there is an increase compared to before learning; learning outcomes score is better than the control group learning outcomes score; (c) student responses obtained 90.6%; (d) there is a relationship of 0.437 between motivation and student learning outcomes scores. It was concluded that hydrocarbon learning using the game House of Chemistry as a learning media had a positive impact on student learning motivation, there was an increase in student learning outcomes, and the experimental group learning scores were better than scores of students' control groups giving positive responses and positive correlation between motivation and student learning outcomes

Keywords

Chemistry, completeness, house of chemistry, learning media, motivation.

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Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

Introduction

Chemistry is the study of the properties and composition of matter, including compounds and their changes. Chemistry subject is characterized by its abstract and complex material, such as the process of electron movement, which the eye cannot observe. For this reason, three levels of representation are needed for better understanding through visualization: macroscopic, submicroscopic, and symbolic levels (Ashadi, 2009). The learning process of chemistry is often less interesting and boring, causing students to feel less motivated and have low learning outcomes. The use of media, especially computer games, can make the learning environment more enjoyable and motivating to improve student learning (Smaldino et al, 2019).

According to the results of preliminary research on 90 students in three schools in East Java, Indonesia, 67-75% stated that learning information related to hydrocarbon material is difficult. The topic of hydrocarbon needs to be empowered first by students before they dive deeper into the subject matter, including hydrocarbon derivatives, reactions, and their benefits. Participants also indicated that learning is less interesting because they get bored quickly and are less motivated to learn, so learning this subject requires a more enjoyable learning atmosphere, one that arouses motivation, enthusiasm, and can improve learning outcomes. According to Sanjaya (2018), interactive media, such as games, can be used as learning media. The game as a learning media aims to help students learn independently. It promotes a creative atmosphere for students, so learning can be more interesting (Priatmoko et al., 2012). We believe that the game can provide a pleasant learning atmosphere so that student's motivation to learn increases. This is also in line with the results of interviews with chemistry teachers who said that playing games help when students learn about hydrocarbons.

Games can provide a variety of learning experiences and can be used for various classroom situations. It can be challenging, fun, and inseparable for students. Through games, students can demonstrate the ability to solve and master problems (Kalogiannakis et al., 2021) and an effective way to get students' attention to learn certain topics or skills [49].

Games can be applied in learning events and programs (Kalogiannakis et al., 2021). The study of individual learning indicates that computer or mobile games can increase students' motivation to study. Games enable students to engage in interactive learning environments, increase information retention (Lutfi et al., 2021), and improve their problem-solving skills (Huang et al., 2018).

Interactive media that can be used as a medium for learning is a game (Mozelius et al., 2017). The game as a learning media aims to help students learn independently. It can create a recreational atmosphere for students so that learning can be more interesting (Carrillo et al., 2019). De Freitas (2006) states that one advantage of games is that they can motivate students to develop and improve their level of learning. Additionally, motivation can act as a driver for learning activities in students, which can assist students in achieving their goals.

Having motivated by previous studies, in this work, House of Chemistry consisting of games that have been modified as learning media on hydrocarbon materials were developed. House of Chemistry is a 2D game that describes someone who is trapped in a

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

chemical house. House of Chemistry ends when players can get out of the house by passing various obstacles. The obstacles players face contains practice questions, and these are obstacles that can train students' thinking skills in problem-solving and decision making.

House of Chemistry is a game that tells of a child named Mia who is trapped in her aunt's house, Aunt Kim. When Mia wants to go out to play with her friends, Aunt Kim gives her tasks to complete. The tasks are to collect carbon atoms, hydrogen atoms, and some useful items from hydrocarbon compounds. The game ends when the player can get out of the house after passing various obstacles. The obstacles contain practice questions to develop students' thinking skills in problem-solving and decision making.

The House of Chemistry game has met the eligibility criteria of instructional media based on its validity, practicality, and effectiveness (Ningrum and Lutfi, 2019). This study explains what students learn and how their motivation can increase after learning about chemistry topics using the House of Chemistry.

Methodology

The study was conducted in two classes at different high schools in East Java, Indonesia, each for two 90-minute meetings in 2019. Class determination was carried out randomly on students who had met the requirements for hydrocarbon learning. The study was conducted using the Pre-test-post-test control-group design system; namely, there were control groups and experimental groups, with randomized group determination. Before conducting learning, activities using the game, students were given a pre-test in the form of questions that aligned with the learning objectives. Then, the post-test was conducted to discover student learning outcomes after learning to use the game. The pre-test was conducted the day before the implementation, and the post-test was after learning ended. The question form was randomly determined by two schools, each as a control and an experiment. Each school then designated random classes that will be participated in the research. The design of the study is illustrated below.

Control: O1 X1 O2

Experiment: O1 X2 O2

Note:

O1: Pre-test score before learning

O2: Post-test score after learning

X1: Learning by using media in the classroom

X2: Learning by using the game House of Chemistry as a learning medium.

Student Motivation Analysis

The student motivation questionnaire results were analyzed descriptively quantitatively. The results of the student motivation questionnaire show the game can motivate students in learning. The score provisions are calculated based on the Guttman scale criteria in Table 1 (Riduwan, 2012).

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

Table 1. Guttman scale criteria.

Answer	Score
Yes	1
No	0

Each student calculated their motivation according to the answer, and then we calculated the motivation of each aspect of motivation and the percentage of students' motivation after learning using the House of Chemistry game. The results of the motivation questionnaire will be used to determine the level of learning motivation by using the interpretation of the scores in Table 2 (Riduwan, 2012).

Table 2. Percentage of motivation criteria.

Percentage (%)	Criteria
0-20	Very Low
21-40	Low
41-60	Enough
61-80	Good
81-100	Very good

Analysis of Student Learning Outcomes

The pre-test and post-test scores were analyzed by a paired t-test to find out the difference between the pre-test scores and post-test scores. We performed classical completeness determinations on post-tests in the control group and the experimental group. The post-test score of the control group was compared with the post-test score of the experimental group with an independent t-test. Calculation of normality distribution, paired t-test values, independent t-test values, and correlation coefficient values were carried out with the help of SPSS version 16.

Analysis of Student Response Questionnaire

Student response data were analyzed descriptively quantitatively (Equation 1). In the student response questionnaire, there were positive and negative statements. Scoring was done based on the Guttman scale score in Table 3 (Riduwan, 2012). The criterion for a positive response was whether the percentage had reached ≥ 61 good categories.

$$\text{Percentage of response for each aspect}(\%) = \frac{\text{number of student answer a scores}}{\text{the number of students}} \text{ x } 100\% \quad (1)$$

Table 3. Guttman's scale score.

Answer	Score positive question	Score negative question
Yes	1	0
No	0	1

Results

Analysis of Student Response Questionnaire

The result of student motivation as it relates to each aspect can be seen from the data in Table 4. Based on the data contained in Table. 4 ARCS model, student motivation gets a percentage of each aspect, ranging from 82% to 100%, and if the average is 94.5%, this suggests that the category excelled in motivating student learning. Student motivation scores are presented in Table 5.

Student motivation is based on the results of student motivation questionnaires filled out by students after using the game in the learning process. The motivation questionnaire was given to discover whether the game could motivate student learning. Student motivation is measured by reference to motivation theory proposed by Keller and Suzuki (2004) who compiled a model to measure learning motivation using the Attention, Relevance, Confidence, and Satisfaction (ARCS) model.

Table 5 shows the motivation of students after learning using a Very Good House of Chemistry game. This means that by using computer-propelled games, students will be motivated to learn and play so that they come to enjoy learning chemistry. This is capital that is very useful for achieving success in learning chemistry.

No.	Statment	Percentage
	ATTENTION	
1	What I learned with the House of Chemistry game was useful for me.	94% Very Good
2	The teacher conducts learning in a way that is different from usual, and it is very interesting.	100% Very Good
3	Learning with the House of Chemistry game makes me want to know about the learning material discussed.	94% Very Good
	RELEVANCE	
4	The practice questions given in learning with the House of Chemistry game make learning material important.	97% Very Good
5	I must study hard to succeed in learning with the House of Chemistry.	91% Very Good
6	During the learning activities, I tried to follow and get good marks.	94% Very Good
	CONFIDENCE	
7	I am sure I can take part in learning with the game House of Chemistry.	97% Very Good
8	I am sure I will succeed in following this lesson if I study hard.	100% Very Good
9	I feel that success and failure depend on me.	100% Very Good
	SATISFACTION	
10	I like to learn with games like House of Chemistry.	94% Very Good
11	The content of these lessons is following my expectations and goals	82% Very Good
12	I feel I have received many awards for all the efforts that have been made in this learning in the form of values, comments, and feedback.	97% Very Good

Table 4. Student motivation results.

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

The motivation scores of students in the experimental group are presented in Table 5.

Table 5. Motivation scores of experimental groups.

Score (%)	The number of students
83.33	1
91.67	18
100.00	15
Total	34

Student's Learning Outcome

The impact of learning is measured using the House of Chemistry as a learning medium. Student learning outcomes are known based on the pre-test score, which is assessed before learning, while the post-test is conducted after learning.

Regarding the aspect of attention, the percentage score starts from 94% to 100% and is in a Very Good category, meaning that House of Chemistry has been able to maintain students' attention in the learning process. The combination of various strategies in choosing animation and game themes is very good in maintaining students' attention. Keller and Suzuki (2004) also explained the importance of combining various strategies to get students' attention such as using interesting graphics, animations, or any type of intervention that causes conflict. This is consistent with the research conducted by Arum and Lutfi (2012) that game media can foster curiosity in students.

To test whether there is a significant difference between the average pre-test score and the post-test score of the control group and the experimental group paired t-test, the normality test is performed with the help of the SPSS program. The results of the Kolmogorov-Smirnov normality test at the pre-test and post-test stages of the control group can be seen from the data. The value of the sig pre-test score and the post-test score is greater than 0.05, meaning that the two groups are normally distributed so that they meet for paired t-tests. The results of the paired t-test control groups are presented in Table 6.

Table 6. Control group paired t-test.

Score	Average	Sig	t count	Sig (2-tailed)	df	t table (α =1%)
Pretest	31.470	0.150	25.669	0.00	33	2.75
Posttest	79.853	0.089				

Students feel that the game is useful, or very interesting, making it curious that this finding is following the results of research by Sousa Lima et al. (2019) which suggested that students who use learning media games have higher test performances compared with students who study nomenclature only with conventional media.

The value of the t count is in the rejection area of Ho and Ha acceptance, so there is a significant difference between the average score of the pre-test and the post-test score. This means that there is a significant increase in the pre-test score to the post-test score in the control group. If the study's completeness is examined in the control group, it can be presented (see Table 7).

The results in Table 7 indicate that at the end of the learning group, the control group had not achieved the expected completeness, that is, at least 80%; however, the post-test score had a significant increase compared with the pre-test score. The learning outcomes of the experimental group were analyzed to test whether there was a difference between

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

the average pre-test score with the post-test score and the normality test first as a paired t-test requirement.

As far as the Relevance aspect, the scores obtained by the three statements in this aspect are included in the excellent category, namely 91% to 97%. In other words, the game of House of Chemistry has clear objectives and can motivate students to strive to achieve these goals. Relevance learning needs to be built because attention and curiosity are requirements for building motivation, but they are not enough. Therefore, students must understand the requirements in learning to be consistent with the initial goals. Having clear goals is a key component of relevance.

Table 7. Control group completeness.

Score	Lowest Score	Highest Score	Completeness	
			Total	Percentage (%)
Pretest	15	45	0	0.00
Posttest	70	90	24	70.58

The results above show that at the end of the learning group the control group had not achieved the expected completeness, ie at least 80% but the posttest score had a significant increase in the pretest score. The learning outcomes of the experimental group were analyzed to test whether there was a difference between the average pretest score with the posttest score and the normality test first as a paired t test requirement.

The value of the sig of the two groups respectively, at 0.64 and 0.53, meaning that it is greater than 0.05, which suggests that it is normally distributed and can be tested with t in pairs. The results of the paired t-tests are shown in Table 8.

Table 8. Experimental t-test paired tests.

Score	Average	Sig	t count	Sig (2-tailed)	df	t table (α =1%)
Pretest	31.911	0.64	32.584	0.00	33	2.75
Posttest	89.558	0.53				

It turns out that the value of t count is outside the rejection area of Ho and means Ha is accepted so it can be concluded that there is a significant difference between the average score of the pretest with the average score of the experimental group posttest. These results are in accordance with the results of Rastegarpour and Marash (2011) that computer games are effective tools for learning chemical concepts and improving learning outcomes

Material and practice questions in the game are considered important for students who want to succeed and get the best results. This attitude will help students to succeed in learning chemistry (Park, 2012). The Confidence aspect gets a percentage score of 94% to 100%, and it is in the Very Good category, meaning that House of Chemistry has fostered confidence in students in the learning process. Importantly, self-confidence is needed for building motivation. Self-confidence can be achieved by helping students set positive expectations for success so that they can strive in their abilities rather than relying on luck to achieve success. It is advantageous for students to feel confident that they can take part in learning, that they're sure to succeed and achieve self-determined success. Such attitudes, if possessed by students, have great hopes for promoting learning success (Sousa Lima et al., 2019).

The degree of completeness in the experimental group is presented (see Table 9).

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

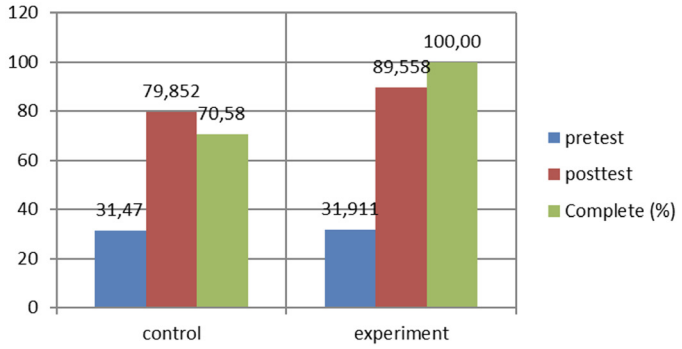

FIGURE 1. Prestest score, posttest score and the completeness of control and experiment group.

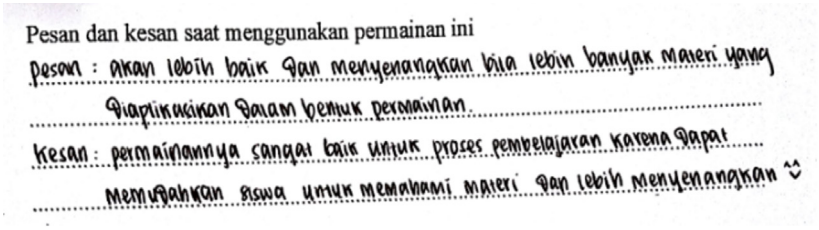

FIGURE 2. The example of student's advice.

Figure 1 shows the increase in the pre-test average score and post-test average score within the control and experimental groups. The experimental group reached completeness while the control group did not. To test whether there was a significant difference between the average score of the control group post-test with that of the experimental group, the post-test scores of the two independent groups were assessed with the independent t-test and the results (see Table 10).

TABLE 9. Experimental group completeness.

Score	Lowest Score	Highest Score	Completeness	
			The number of students	Percentage (%)
Pretest	20	45	0	0.00
Posttest	80	100	34	100

TABLE 10. Independent t-test results posttest control and experiment score.

Group	Average	The number of students	t count	df	t table (α = 1%)	Sig (2- tailed)
Control	79.852	34	5.582	66	2.66	0.00
Experiment	89.558	34				

The value of t count (5,582) is greater than t table (2.66) at the significance level of 1% so that being in the rejection area Ho means Ha is accepted, meaning there are significant differences between the mean posttest score of the control group and the experimental group at a significance level of 1%. These results indicate that the use of the House of Chemistry game as a learning medium provides better learning outcomes than the class without using games and has achieved the expected classical completeness, which is greater than 80% and according to the results of research by Sousa Lima et al (2019).

TABLE 11. Motivation correlation test and pretest score.

** Correlation is significant at the 0.01 level (2-tailed).

		Post-experiment	Students' motivation
The score of post-experiment	Pearson Correlation	1	.437**
	Sig. (2-tailed)		.010
	N	34	34

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

The results of the data in Table 11 show that after learning, the experimental group arrived at the specified classical completeness, which is 100%, and the conditions used were greater or equal to 80%. The comparison of pre-test average score, post-test average score, and classical completeness between the control group and experimental group is shown in Figure 1.

The value of the t count (5.582) is greater than the t table (2.66) at a significance level of 1%. This means that being in the rejection area, Ho, means Ha is accepted, which indicates significant differences between the mean post-test score of the control group and the experimental group, at a significance level of 1%.

Correlation Between Student Motivation and Learning Outcomes

The correlation between students' learning motivation scores and post-test chemistry scores in the experimental group was calculated by the Pearson correlation coefficient with the help of the SPSS program. The results show a positive correlation between motivation and learning outcomes, which is 0.437 (see Table 11).

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 Carrillo et al. (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, thereby achieving meaningful learning.

Student Satisfaction Response

The correlation between Student response data completed by 34 students after learning using the House of Chemistry game as a learning medium on hydrocarbon material is presented (see Table 12). Based on the data, the percentage of responses was 71% to 100%, including Very Good categories. The following explanation is distinguished based on the objectives of each statement. Responses to aspects of the game's usefulness were 71% and 94%, indicating that the House of Chemistry can help students understand hydrocarbon material. Students have also provided written insights suggesting the possibility of a game for other learning materials because learning to use games is fun and not monotonous.

In the aspect of Satisfaction, the results obtained were 82% to 97%, meaning that the House of Chemistry, as a learning media tool, has provided a satisfying learning experience for students. In addition, the House of Chemistry equips students with a high level and ongoing motivation to learn. Satisfaction is needed so that students have positive feelings about the learning experience. If this condition is met, students not only have a high level of motivation to learn but also have continuous motivation for learning.

Students feel happy to learn when the content of learning is following their expectations, and there is feedback on what has been done. Motivation for success increases after failure, so students who have previously experienced failure work to succeed. There is a significant difference between the average score of the pre-test with the average score of the experimental group post-test. These results are following the previous results

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

(Rastegarpour and Marashi, 2011), which indicated that computer games are effective tools for learning chemical concepts and improving learning outcomes.

Table 12. Student response results.

No	Statement	Percentage of Response
	To find out the level of usefulness of the game	
1	Learning to use the game "House of Chemistry" can help me understand the concept of hydrocarbon material	94% Very Good
2	I can study on my own even though I am not in learning	71% Good
	To obtain the level of student interest in the game as a learning media	
3	* I did not feel challenged at all when running the game "House of Chemistry"	88% Very Good
4	Learning chemistry using learning media in the form of very fun games	100% Very Good
5	I feel interested in the game "House of Chemistry"	91% Very Good

Discussion

House of Chemistry can be used as an alternative for teachers when discussing hydrocarbon. It can increase the motivation of students to learn and finally improve student learning outcomes. This research was limited to one control class and one experimental class, and the chemistry learning time with games as learning media was carried out with two meetings of 90 minutes each.

The second statement reads: "I can study on my own even though I am not in learning." As many as 71% of participants agree about being able to learn on their using games even when they are not in the good category. This can be seen in the enthusiasm of students when running the game because several students want to keep playing even though in the first 10 minutes they have experienced "game over." However, they keep trying to finish the game. In other words, although they may not be learning, students will continue to learn on their own because they feel learning to use the game is very fun. This statement gets the lowest percentage compared to the others. As many as 29% of students do not agree with this statement. In other words, as many as 29% of students want learning to continue in the classroom, meaning that some students still want to learn with the game as a learning media on the condition that there are teachers and other sources so that it is part of classroom learning rather than independent learning. This is following the initial goal that the game be a form of learning media because it is used in the classroom. For more benefits, 71% of students agree that the game can be used anytime and anywhere, and it is not necessarily just for classroom learning.

Three statements relate to the aspects of student interest in the game as a learning medium. The results obtained by students' responses amounted to 88% to 100%, meaning that the students feel challenged when playing the game, students have fun when playing and learning, and students are interested in playing House of Chemistry. This shows that the level of student interest in House of Chemistry is very high. This is in following with Anastasiadis et al. (2018) namely, that games encourage motivation and student involvement in learning. This result is something that would be very positive to maintain in

Volumen 34 | Número 1 | Páginas 176-187 | enero-marzo 2023
http://dx.doi.org/10.22201/fq.18708404e.2023.1.82798

learning chemistry so that chemical learning is awaited by students, and so that the game has a positive and active role in this endeavor (Akkuzu and Uyulgan, 2016).

Conclusion

Learning hydrocarbons using the House of Chemistry game was proven to motivate students to learn chemistry. This learning media can achieve more classical completeness compared to traditional learning. There is a positive relationship between learning motivation and learning outcomes. Students were satisfied with the use of games as they found it useful to provide an understanding of the study material and make them interested in continuing to learn. The House of Chemistry game as a medium for learning chemistry subjects is not only easy to operate but also very interesting. Therefore, games can be a solution to improve students' memory and understanding.

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