



Development of Flappy Chem Game Media on Electron Configuration Materials on Students' Happiness Level

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Abstract: This study aims to produce the Flappy Chem game as a learning media on electron configuration material referring to the feasibility indicators, namely the validity, practicality, and effectiveness of the developed game media. This study uses a 4D development model. The instrument used is a validation sheet, student response questionnaire sheet, student happiness level questionnaire sheet, pretest, and posttest. The limited trial was conducted at SMA Negeri 3 Sidoarjo with a total of 30 students. The results of the validity test got a score of more than 3 with good categories. Practicality scores get an average percentage of <85% for each goal with a very practical category. The effectiveness score can be seen through the learning outcomes of students and the level of happiness. Classical completeness achieved is 87% and the level of happiness of students is 83% with a very effective category. Based on this explanation, it can be concluded that the Flappy Chem game media has met the feasibility indicators, namely validity, practicality, and effectiveness so that it can be used as a game-based learning media.

Keywords: learning media, electron configuration, happiness, flappy chem

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INTRODUCTION

Electron configuration material is a useful chemical material for studying the following subject matter. Electron configuration is an abstract material and tends to make students have difficulty understanding it. This can be improved with the existence of learning media. Learning media includes aids that can be displayed, spoken communication, print media, still images, moving images, sound films, and machine learning and can offer information, knowledge, and new experiences to interactions between teachers and students as well as amongst students (Daryanto, 2016).

The electron configuration material is still considered a difficult material because it is abstract and cannot be observed directly by the ordinary eye. Although this topic looks easy and simple, it is a difficult topic for students. The learning process can be assisted by using learning media. According to Fernanda et al. (2020) students get low learning outcomes on electron configuration material because they have difficulty imagining the abstract nature of the electron configuration in the form of orbitals, how to fill electrons, terms sub-orbitals or sub-shells, and so on. This often becomes confusing for students to understand the difference in each of the existing terms.

Media is something that transmits messages and can stimulate the thoughts, feelings, and wills of the audience (students) so that it can encourage their learning process in them (Usman & Asnawir, 2002). Anything that can be utilized to transmit messages from sender to receiver in order to pique students' interests and stir their thoughts, feelings, and worries is considered media. This was also conveyed by Sukiman (2012) that Everything that can be utilized to transmit a message from the sender to the recipient in order to pique students' interests and motivate them to learn in order to successfully accomplish learning objectives. Learning media designed must be able to stimulate the emergence of a process or dialogue in students. In other words, communication occurs between students and the media, or indirectly communication can occur between students and message distributors (educators). Thus, the message of learning can be conveyed properly.

Game-based learning media are very popular with students today, therefore games can be used as a teacher's tool in delivering material in more detail and with more interest. According to Lutfi et al. (2019) in a case study on Successful Learning of Chemical Bonds Using Chebo Collect Game, gamification can be used as one of the media used in education, especially as a learning medium where the game is computer-based and has passed the validation, practicality test, and effectiveness. Games can involve students in interactive and active learning, create a sense of joy and motivate students in learning (Yolanda & Iswendi, 2019).

Happiness will cause a person to feel happy. This feeling of happiness can affect student learning outcomes, both at school and home. According to Okfia and Hazizah (2017), a mood that develops into fun for children will bring up a sense of joy which can increase children's intelligence. The relationship between

happiness and learning outcomes can be explained by the relationship between affective and cognitive aspects of brain work. According to [Zaini \(2019\)](#), through playing all aspects of children's development can be improved, and playing can also strengthen the things that have been obtained and discovered by children.

The flappy chem game media is one of the media that can be used in the learning process on electron configuration material. This flappy chem game media is adapted from the flappy bird game which is very popular among teenagers. In a journal belonging to [Fathihah et al. \(2019\)](#), it was explained that a flappy bird is a game that demands concentration from the players, the main character of this game is a bird. The flappy bird game was made by a game developer named Nguyen Ha Dong from Vietnam and was released in 2013. Players are asked to move the flying bird to get through the green pipes by tapping the player's finger on the cellphone layer. While in flappy chem, the game procedure is not much different from a flappy bird. The main character in the game flappy chem is a red bird who flies with the help of a finger tap on the screen, then he has to make his way through the green pipes. Everytime they pass one pipe, they will get a score of 1, but when the bird hits the pipe, it does not get points and must answer questions about chemistry, namely the material of electron configuration correctly.

Through the times, it can also affect the development of science and technology that drives our efforts in the learning process ([Siregar, 2021](#)). Learning media can provide a direct learning experience to students, because it has a positive impact such as making learning more interesting and interactive and can explain abstract material into concrete such as electron configurations ([Sari et al., 2020](#)), in addition, understanding of chemical concepts that are considered abstract is also a formidable challenge for students ([Li et al., 2022](#)). With learning media, the meaning or message conveyed by educators becomes clearer ([Ilmiani et al., 2020](#)). Learning media can be game-based, games can increase understanding of the material and motivate students to improve learning achievement so that they can make game-based learning media as an alternative for students who feel not interested in learning ([Syahidi et al., 2021](#)).

Currently, there is no game as a learning medium that discusses electron configuration material so the researchers develop a flappy chem game media on electron configuration material with the hope that the level of happiness and learning outcomes obtained can make this flappy chem game media used in chemistry subjects. The purpose of this study is to produce game-based learning media that is feasible to obtain from validity based on the assessment of the validator, practicality based on the student response assessment sheet, and effectiveness based on the happiness level assessment sheet and student learning outcomes from the pretest-posttest results to be used in the learning process of electron configuration material.

METHODS

This study used the 4D development method written by Thiagarajan. This 4D development method had 4 stages, namely defining, designing, developing, and disseminating ([Sugiyono, 2018](#)). The 4D research scheme is presented in Figure 1.

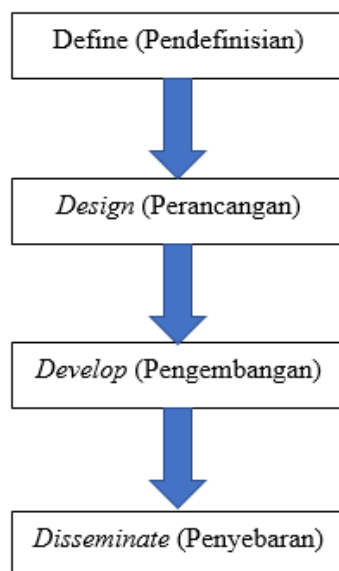


Figure 1. The stages of using the 4d method

Define stage (define)

At this stage, the researchers discovered information about problems in schools related to the learning process, the use of learning media, and the learning methods.

Stage of Design (design)

At this stage, the aim was to produce a game media design in the form of a framework design. The design includes program flow, input, and output display design, material to be presented and questions to be answered.

Development Stage (develop)

The product development stage began with the game production process as a learning medium. The design of application framework that had been designed would be developed into game products as learning media. In the production process, materials and teaching materials were also collected as well as questions that would be included in the flappy chem gamemedia. This stage was also aiming to get the product of the flappy chem game media as a validated and revised learning media based on suggestions from three validators. The validators came from two lecturers of the Chemistry Education Study Program and one chemistry teacher at the school. This media game was conducted in a limited trial to students of SMA Negeri 3 Sidoarjo in class 11 science 3 with 30 students. This limited trial involved one-group pretest-posttest design without a comparison group. The results of the pretest and posttest were used to determine the increase in student learning outcomes.

Dissemination Stage (disseminate)

At this stage, the flappy chem game media would be socialized to students and chemistry teachers at SMA Negeri 3 Sidoarjo.

Data Analysis

The data analyzed in this study were validity analysis, practicality analysis, and effectiveness analysis. The data on the validity of the flappy chem game media by the validator consisting of chemistry lecturers and chemistry teachers were analyzed by the percentage of the scores on the assessment sheet. The validity assessment sheet was based on the Likert scale assessment criteria in Table 1.

Table 1. Likert scale grading criteria

Scale value	Assessment criteria
1	Invalid
2	Not valid
3	Quite valid
4	Valid
5	Very valid

Analysis of Student Response Questionnaire Results was used to obtain practical data analysis using the flappy chem game media. The results of the quantitative analysis were measured using the Guttman scale. The Guttman scale is shown in Table 2.

Table 2. Guttman Scale

Question	Answer Score "Yes"	Answer Score "No"
Positive	1	0
Negative	0	1

The percentage results of the student response questionnaires were converted into interpretation criteria scores based on the Guttman scale (Sudjana, 2005) which were presented in Table 3. If the percentage was 61%, then this flappy chem game media can be declared practical.

Table 3. Guttman Scale Interpretation Score

Percentage (%)	Category
0-20	Very Ineffective
21-40	Less effective
41-60	Effective enough
61-80	Effective
81-100	Very effective

The effectiveness can be seen from the results of the questionnaire on the level of happiness as well as the pretest and post-test. This Flappy Chem game media can later be said to be effective from the results of the pretest and posttest on the electron configuration material. If the results of the pretest of all students were incomplete because the pretest score did not reach the Minimum Completeness Criteria (KKM), which is 70, then the process of using game media as learning media was carried out and after that, a posttest is carried out. The results of the posttest, all students reach the KKM, then they have fulfilled classical completeness. Classical completeness can be achieved if the percentage of students who have achieved this completeness was 75% (Azizah, 2016).

Then the data from the pretest and post-test were analyzed using the normality test and t-test with the help of IBM SPSS Statistics 23. In the paired sample test, the results of the pretest and posttest can be said to have a difference in the average score if the significance value (2-tailed) was less than 0.05 (Saputri, 2016). According to Siti et al. (2022), if the significance value was more than 0.05, it can be said that the normality test was normally distributed. In the questionnaire on the level of students' happiness towards the flappy chem game media, the data analysis used a Likert scale. The Likert scale was a psychometric scale that was commonly used in questionnaires and was also widely used in research such as surveys (Taluke et al., 2019). The Likert scale can be seen in Table 4 below.

Table 4. Likert scale

Score	Category
1	Strongly Disagree
2	Don't agree
3	Just Agree
4	Agree
5	Strongly agree

The results of the percentage of the questionnaire on the level of students' happiness, were converted into a score of interpretation criteria based on the Guttman scale (Sudjana, 2005) which is presented in Table 5. If the percentage is 61%, then this flappy chem game media can be declared effective.

Table 5. Guttman Scale Interpretation Score

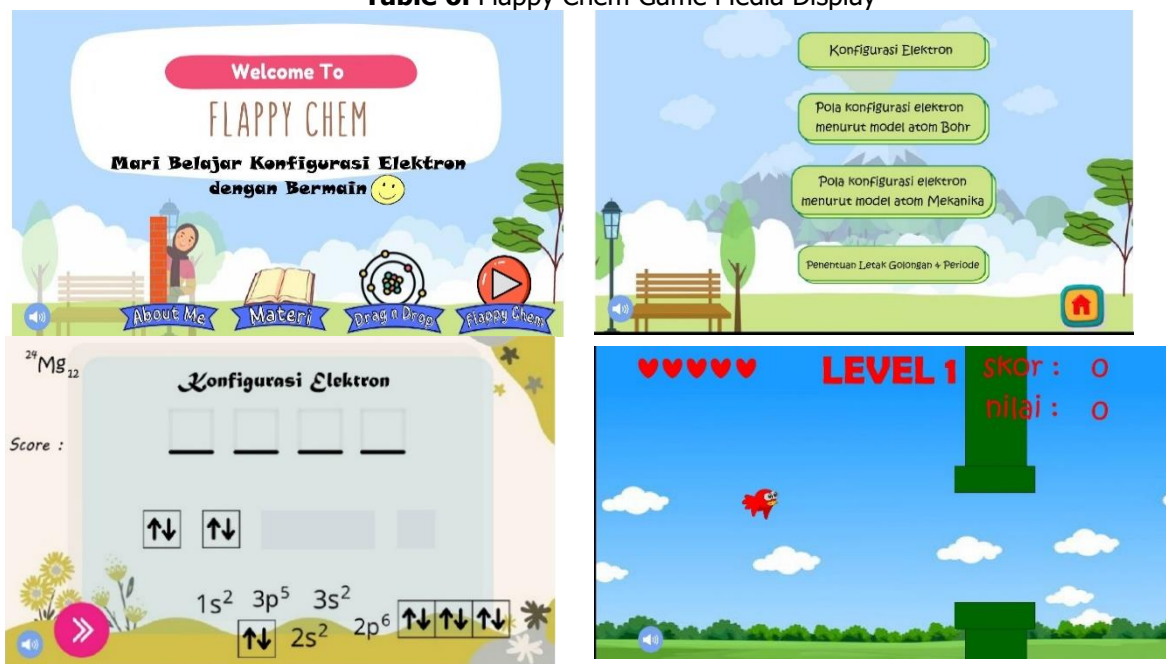
Percentage (%)	Category
0-20	Very Ineffective
21-40	Less effective
41-60	Effective enough
61-80	Effective
81-100	Very effective

RESULT AND DISCUSSION

This flappy chem game media is adapted from the flappy bird game which has been modified in such a way that it is not only a game but also contains material and questions regarding electron configuration. There is a video explanation of the sub-material that can make it easier for students to understand it and can create a fun learning atmosphere. In a journal belonging to Fathihah et al. (2019) it is explained that flappy bird is a game that demands the concentration of the players, the main character of this game is a bird.

At this stage, the researchers explore information related to problems in the learning process. Most students feel bored if learning is only done in a teacher center. It takes learning media as a means to overcome boredom during the learning process. This is reinforced by research (Junaidi, 2019) that the use of media will help in the effectiveness and delivery of messages and content in learning at that time. In addition, it can improve students' understanding and interpretation of data. This stage also produces components that have been designed on the game media, such as the materials used, learning videos, and practice questions that will be used in the flappy chem game media. At this stage, the researchers began to search for and compile the contents of the game media. This flappy chem game is adapted from the flappy bird game, where the game is mostly played by children to teenagers. In this media, the flappy chem game contains material that contains learning videos and explanations about electron configuration, then the Drag n Drop menu contains practice questions in the form of a puzzle game, and the flappy chem menu contains the flappy chem game and profile menu. The instruments prepared at this stage were the validation of the game media, student response questionnaires, student happiness questionnaires, and questions for pretest and posttest.

Making game media using Adobe Flash CS6 (Action Script 3.0) and Adobe Animate CC 2019 applications to convert game media so that it can be based on Android. Other applications used to design backgrounds and other ornaments on media are Corel Draw 2020 (64Bit) and <https://canva.com/> which can be accessed through a browser such as Google Chrome or Mozilla Firefox. The learning video is obtained from Faradhilla Rahajeng's Youtube Channel which discusses the electron configuration pattern according to the Bohr atomic model, the electron configuration pattern according to the mechanical atomic model as well as determining the location of groups and periods. The results obtained from this stage are the display design of the flappy chem game as a learning medium made using some of the applications above. The results of the media display can be seen in Table 6.

Table 6. Flappy Chem Game Media Display

Validity

The third stage is development which at this stage produces a flappy chem game media that has been validated and there are several revisions according to suggestions from the validator. The validators came from two chemistry lecturers and one chemistry teacher. There are two criteria of validity, namely content validity and construct validity. Content validity is an assessment in terms of the truth of the concept of knowledge and has a purpose in learning (Al-mira & Hidayah, 2020). Meanwhile, according to Ihsan (2015) construct validity is an instrument that measures the construct to be achieved and requires a process to be carried out in content validity. The results of the revision of the validator can be seen in Table 7.

Table 7. Game Media Revision Results Table

Before Revision	After Revision

Added a question explanation display when answering incorrectly

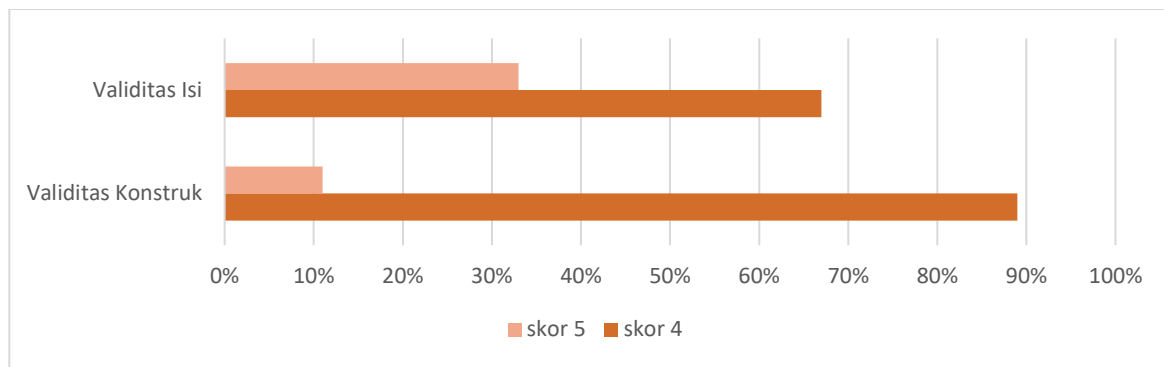


Figure 2. Validation Results

Based on Figure 2 above, content validity gets a percentage of 66.6% from a score of 4 and a percentage of 33.3% from a score of 5. This shows that the flappy chem game media on content validity can be said to be valid based on the results of the assessment from the validator. In content validity, two aspects are assessed, namely 1) the truth of the concept and 2) The suitability of the material in the game with the goal. The one who gets the highest percentage is in the aspect of the suitability of the material in the game with the objectives that can be seen in the media through materials and questions, guides in the game media as well as pretest and posttest.

Construct validity got a score of 4 with a percentage of 88.8% and a score of 5 with a percentage of 11% based on the results of the assessment from the validator. It can be said that this flappy chem game media is very valid. This is supported by research from [Sumitro and Zuhrie \(2019\)](#) regarding the validation results of Maze Runner learning media which get a very valid category with a percentage of 84.5%. According to Sumitro, if you get a rating result equal to or more than 63%, it can be concluded that the learning media is very feasible to use.

Practicality

The practicality of the game media can be determined from the response of students after using the flappy chem game media. Students' responses are obtained from questionnaires that are distributed and have been categorized based on indicators. This practicality criterion refers to the level of product developed and liked by students. The data from the practical test can be seen in Table 8.

Table 8. Table of Student Response Results

Destination	Percentage	Category
To find out the students' interest in the game Flappy Chem	93.3%	Very effective
To find out the level of ease of use of the game as a learning medium for Electron Configuration material	88.3%	Very effective

Based on the results of the student response questionnaire recap above, it shows that the purpose of this student response questionnaire which obtained the highest average percentage of 93.3% is to determine the interest of students in the Flappy Chem game. Three aspects are assessed from these goals which get a percentage of 96.7%, namely students feel motivated to learn, to help students in independent learning, and students' interest in playing this game media. It can be interpreted that students are interested in using the flappy chem game media in the learning process of electron configuration material and can understand the concept of material through this game media.

In the second objective, which is to determine the level of ease of use of games as learning media for Electron Configuration material, the average percentage of 88.3% is included in the very effective category. Aspects that are assessed from these goals that get the highest percentage of 100% are students can understand the rules of the game. This can be interpreted as this flappy chem game that includes procedures and rules of play and is very easy to understand by students. The explanation above relates to research from [Sumitro and Zuhrie \(2019\)](#) entitled Development of Maze Runner Educational Games as Learning Media for Basic Electrical Electronics for Class X Students at SMK Negeri 1 Jetis Mojokerto stated that learning media in the form of educational games can attract the attention of students in the learning process and can be used as an alternative teaching aid that is easy to use.

Based on research from [Lutfi et al. \(2021\)](#) entitled Applying Gamification to Improve the Quality of Chemistry Teaching and Learning in Senior High School it is explained that students who have more learning experiences are learning facilitated by games as computer-assisted learning media. This can be an additional

insight and learning skills of students and can make chemistry learning process more interesting, thus can make students want to be more involved in using these computer-based games.

Effectiveness

Data on the effectiveness of game media can be obtained from the level of happiness of students in using the media. The questionnaire on the level of happiness of students was obtained through filling out questionnaires that aimed to see an increase in the feeling of happiness in students after using game media and later it could affect their learning outcomes. Data on the results of students' happiness levels can be seen in Table 9.

Table 9. Happiness Level Questionnaire Results Table

Destination	Percentage	Category
To know the level of happiness	84.3%	Very high
To know self-satisfaction	83%	Very high
To know creative freedom	85.3%	Very high

The first goal is to find out the level of happiness, this goal includes the level of happiness of students in playing flappy chem. The average percentage generated in this first goal is 84.3%. This can be interpreted that students enjoy and like every part or component in the flappy chem game media. Two aspects have the highest percentage value of this first goal of 86.7%, that aspect is that students enjoy the game and animation of flappy chem. The explanation above is strengthened by research from Selligman (2005) in the journal of [Shabrina et al. \(2020\)](#). Selligman, a psychologist, states that one of the positive emotions of the present involves enjoyment obtained from activities and makes the individual fully involved. Happiness can be obtained from himself through things that can make him enjoy every particular moment or situation. And this happiness is expected to affect the learning achievement of students.

The second goal is to find out self-satisfaction, this goal shows the satisfaction of students in the game in the scope of being satisfied with their success, completing challenges, and being challenged to continue the game, besides that students also get information in the form of knowledge about electron configuration through this game media. The average percentage generated in the second goal is 83%, which means that students feel self-satisfied in completing challenges. The aspect that has the highest percentage value of this second goal is 85.3%, namely, the game aspect can provide information to achieve the goal.

The third objective is to determine the freedom of creativity, this goal explains the freedom of students in making choices to operate the flappy chem game media. The average percentage generated in this third goal is 85.3%, which the average is the highest compared to the other goals. The aspect that has the highest percentage of these goals is that students can express themselves. According to the Big Indonesian Dictionary, expression is the disclosure or process of stating, namely showing or stating intentions, ideas, feelings, and so on. Meanwhile, the meaning of the word 'express' according to the KBBI is to express with the movement of the limbs, words, and so on. The purpose of the explanation is that students express themselves when operating the flappy chem game media with limb movements and even exclamation words when winning or losing. This can be seen when the data collection process at school by the researchers, and the enthusiasm of students is very high in learning using this flappy chem game media.

Another aspect, which has the highest percentage value of this third objective is the unique and different game media. This flappy chem game is a game medium that was adopted from the original game, namely flappy bird. A study written by [Fathihah et al. \(2019\)](#) about how to play a flappy bird is to fly a red bird using the player's finger tapped on the cellphone screen. The challenge is that the player must keep the bird from hitting the green pipes, if it crashes, the game will end. Happiness is very important for students, especially in the learning process. Using the flappy chem game as a learning medium can help the process of receiving information to students more easily. This is in line with research from [Casinillo and Casinillo \(2020\)](#) that happiness in learning is when students enjoy what they have obtained and are influenced by different factors, where students do not feel pressured and are always in pleasant situations so that it is easier to achieve some goals which have been determined.

Students Learning Outcome

Data analysis of the effectiveness of this flappy chem game media can also be obtained from the results of the pretest and posttest. The pretest was conducted to obtain information about the existing knowledge of the students before using the flappy chem game media. Meanwhile, the posttest was carried out to see the effect of the flappy chem game media on the information knowledge of students after using the media. According to ([Effendy, 2016](#)) the results of the pretest can be used to see how effective the teaching is and later the results from the pretest will be compared with the results of the post-test so that from these results it can be said that the learning process is successful or not. The results of the students' pretest and posttest can be seen in Graph 1.



Figure 1. Graph of Student Learning Results

Based on the graph above, it can be seen that in the pretest results there are no students who meet the KKM standard, which is 70 or the percentage is 0%. The total number of students who did not complete was 30 with a percentage of 100%. Meanwhile, in the posttest results, 26 students could be said to be complete because they obtained results more than or equal to 70. The percentage obtained was 87% and the percentage of students who did not complete was 13%. It can be said that the KKM can be achieved because the total percentage is more than 75% (Azizah, 2016). Analysis of the normality test and t-test of the results of the pretest and posttest using the IBMSPSS Statistics 23 application. The table of normality test results using Saphiro-Wilk can be seen in Table 10.

Table 10. Table of Normality Test Results

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
Pretest	.122	30	.200*	.951	30	.180
Posttest	.169	30	.029	.936	30	.071

The normality test uses the Saphiro Wilk because the number of students is less than 50. Suardi's journal explains that the Saphiro Wilk normality test is a test carried out to determine the distribution of random data in a small sample. Saphiro and Wilk (1958) and Shapiro, Wilk, and Chen (1968) conducted a seminar paper using data simulations of no more than 50 samples, so that if the data sample is less than 50 ($N < 50$) then the Shapiro Wilk test can be used. In the test, Suardi also stated that data is said to be normally distributed if the significance value is > 0.05 (sig. > 0.05) (Suardi, 2019). Based on the results of the Saphiro Wilk normality test using SPSS, a significance value of $0.071 > 0.05$ was obtained so that it was normally distributed.

The T-test is a test that shows how far the influence of one independent variable is individually in explaining the dependent variable (Ghozali, 2011). According to Magdalena and Krisanti (2019) the statistical t-test or t-test was carried out using a significance level of 0.05, and the acceptance or rejection was carried out based on the following hypothesis criteria. If the significance value is > 0.05 , then the null hypothesis (H_0) is accepted and the alternative hypothesis (H_1) is rejected. If the significance value is < 0.05 , the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted. The results of the T-test using IBM SPSS 23 are as follows.

Table 11. T Test Results Table

		Paired Differences					t	df	Sig. (2- tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	- 45.667	9.353	1.708	-49.159	-42.174	- 26.74	29	.000

For H_0 and H_1 can be written as follows:

H_0 : no effect

H_1 : there is an effect

Based on the results of the t-test using SPSS above, the results obtained a significance value (2-tailed) of 0.000 which means the sig value <0.05 so that H_0 is rejected and H_1 is accepted, and it can be said that there is an influence on student learning outcomes through pretest and posttest after using the media game flappy chem. This was also confirmed in the research from Hidayah et al. (2017) entitled The Box of Katik Chemistry Game as a Learning Media on the material of the periodic system of elements, namely that student learning outcomes increase after using the media. Other supporting research from Ramdhani et al. (2020) states that there are differences in student learning achievement after using chemical bonding textbooks with a multi-representation approach.

Based on the suggestion from the validator that the game should be given a duration of time in working on the questions or answering the questions obtained, this is to measure the ability of students to solve problems and students not only memorize answers but also understand them. According to Nurmasyita et al. (2018), the use of time to solve problems greatly affects the steps for solving the questions given. Some students were able to solve the problems within the specified time and get the best results, but not a few students were also unable to solve the problems within that time. This is because students do not find a way out and lack knowledge in working on questions. This knowledge can be found in the material menu in the flappy chem game media. The researchers expect the teachers at schools to develop games as learning media, especially Android-based learning media to attract students' interest in the learning process. In addition researchers expect the teachers to accompany the students in using game media as learning media.

CONCLUSION

Based on the results of this study, the resulting product, namely the Flappy Chem game, can be said to be suitable for use as a learning medium in electron configuration material and can provide happiness for its users. This is because this game media has met the standards in validity, practicality and effectiveness. Practicality scores get an average percentage of $<85\%$ for each goal with a very practical category. The effectiveness score can be seen through the learning outcomes of students and the level of happiness. Classical completeness achieved is 87% and the level of happiness of students are 83% with a very effective category. The results showed that the flappy chem game media affected the happiness level of students so that it could help improve learning outcomes on electron configuration material.

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