



The Development of CIHOE Game As A Learning Media In The Elemental Chemistry Material

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Abstract

The purpose of the research are to develop CIHOE "Chemistry Island: Heaven Of Elements" game as a learning media in elemental chemistry material and also to test the validity, practicality and the effectiveness of the game. The method that used in this research is Gall and Borg development model. The steps are limited to the preliminary field testing. The preliminary field testing step was conducted using one group pretest posttest design. The instrument that used are validation questionnaire, observation sheet, student's response questionnaire, pretest and posttest questions. Data collection were conducted with 15 students of SMAN 1 Menganti. The validity of the game is 91,25 %, which means very valid. The practicality value of the game is 92,6 % which means very easy to operate and useful. The observation result of the student's learning activity is 98,57 %. The classical completeness at the pretest is 13 %, while in the posttest reaches 93 %. It means that CIHOE game is very effective to be used as a learning media in elemental chemistry material. By the development of CIHOE game, researcher hopes that it will help chemistry teachers to explain elemental chemistry material.

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INTRODUCTION

The regulation of the Education Minister in Indonesia No. 22 of 2016 stated that the learning process in the education units must be interactive, fun, and motivate the students to play an active role and provide sufficient space for initiative, creativity, independences according to their talents, interests, physical and psychological developments. Learning is an attempt that designed involves and uses professional knowledge possessed by teachers to achieve curriculum objectives (Suardi, 2018). Nowadays, the trend "freedom of learning" in the pandemic era become an issue in the educational aspect. Student can learn everywhere and every time despite of learning in the classroom. But, student always need helper to study by themselves. Therefore an effective learning is needed to maximize student learning activities, even though the learning activities is independent by student.

Learning activity can be implemented effectively by considering the characteristic of learning materials and the student. The average age of senior high school student is 15-18 years old, known as adolescence. The brain cells grown perfectly in this age. Therefore, student can do high level cognitive activity such as formulate problems and make decisions (Saputra & Munaf, 2020). In this phase, senior high school students would be better if trained to analyze problems during the learning activities. It will helps them to develop their cognitive structure. The learning activities should be more active in student and the teacher has a figure as a motivator. Student have to construct their own knowledge by their learning experiences.

Constructivist learning theory is defined as learning that is generative, namely the act to create a meaning from what is learned (Isti'adah, 2020). This theory emphasizes that learning can be built by humans themselves through their experiences. Learning is more emphasized on process than result. Students are expected to be able to construct their knowledge through their own learning experience. One of the method to implement learning experience is through the media that can be used by students. Media that can be used independently by student can help them to construct the knowledge about the materials.

Chemistry is one of natural science subject that must be learned by science class of senior high school student. One of the material in chemistry is the elemental chemistry. This sub material explain about the abundance of element's ore in universe, the uses of elements in daily life, manufacturing process, physical and chemical properties of

elements. Based on the teacher's interview, the method to explain elemental chemistry material usually by reading the chemistry books. That is why student felt bored while studying elemental chemistry material. Limited availability of media is one of the reason.

The uses of the media in the learning process can affect the student's motivation in learning chemistry. Based on the preliminary research in the SMAN 1 Menganti, the level of student's motivation is in the moderate category. Students who feel unmotivated to learn can be happen because students feel that their needs are not well fulfilled (Badaruddin, 2015). Teacher must deliver and explain well to the students so their needs will fulfilled. The explaining methods to explain elemental chemistry material can be in several different way. One of the method is explaining the material by using a media. It will motivate and catch the attention of the student.

Learning media is anything that can be used to transmit messages in the form of learning materials, so it can stimulate the attention, interest, thoughts and feelings of learners in learning activities to achieve certain learning objectives (Sumiharsono & Hasanah, 2017). The main function of media in learning chemistry is to make the abstract concept become concrete. The uses of media must be appropriate with the learning objectives and the character of the materials. Media can help student to catch the main idea of teacher's explanation about the materials.

Teacher can use game as the learning media in learning chemistry. The fun atmosphere in learning process can make student become active and motivate them to learn more about the materials. Student also become creative and feel not bored during the learning activities. The uses of game in learning chemistry can affect the completeness of student's learning outcomes (Hidayah, Suprianto, & Rahmawati, 2017).

Unfortunately, using of game as a learning media has not been widely implemented in schools. The lack of use of game as a media to study chemistry is due to the limited information from teacher about game-based learning media (Fatimah & Hidayah, 2020). The technological developments have advantages in educational sector, especially in the development of learning media. It is necessary for teacher to implement the game as a media in learning process.

Based on the described things above, the researcher wants to develop a game-based learning media in elemental chemistry called CIHOE "Chemistry Island: Heaven Of Elements". In addition, researchers also want to know the validity, practicality and effectiveness of these games in learning elemental chemistry by tested it to senior high school students. The other purpose of this research is also to introduce

the game-based learning media in chemistry lesson for teacher.

METHODS

The type of this research is the development of game-based learning media. The method that used in this research is Gall and Borg development model. The Gall and Borg development model consists of ten stages in developing a product: research and information collecting, planning, developing preliminary forms of products, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination and implementation (Sutarti & Irawan, 2017). The steps that used in this research are limited to the preliminary field testing.

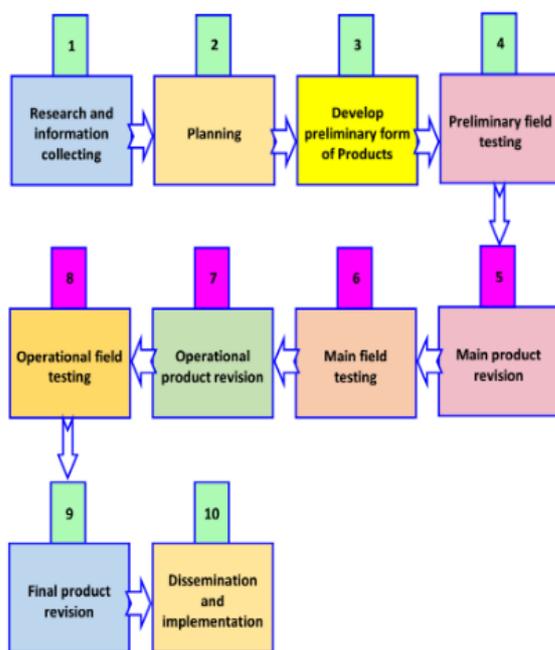


Figure 1. Steps of Gall and Borg development model.

The preliminary field testing step was conducted using one group pretest posttest design. Researcher give the pretest before the treatment (O_1). After the treatment (X), researcher give the student posttest (O_2) to measure the effectiveness of the game as a learning media (Setyosari, 2016).

The data collected in SMAN 1 Menganti in February 2021. The subject of this research are 15 student of XII-science class. Data collecting are use the interview, questionnaire and test. The interview were conducted with one of chemistry teachers. The interview for teacher has purpose to know the method and the media that used to explain elemental chemistry materials. It is also to get the

information about the obstacles during the elemental chemistry learning.

A questionnaire is an instrument in the form of a number of written questions, the aim of which to obtain information from respondents about what they have experienced and know (Siyoto & Sodik, 2015). There are several questionnaire that used in this research: study, validation, and student response questionnaire. The study and validation questionnaire is open, where the validators can state their advice to make some improvement for the developed media. The student's questionnaire used in this study is closed, where the respondent only needs to choose the answer that has been provided.

Study and validation questionnaire use the Likert scale 1-5, which are really bad, bad, enough, good and really good. Likert scale is used to measure a person's attitudes, opinions, and perceptions about something (Herlina, 2019).

Table 1. Score of validation questionnaire (Herlina, 2019).

Statement	Score
Really bad	1
Bad	2
Enough	3
Good	4
Really good	5

Student's response questionnaire and observation sheet are using Guttman scale. There are two options in the sheets, "yes" and "no". For the positive statement "yes" has value of 1, while "no" has value of 0. For the negative statement "yes" has value of 0, while "no" has value of 1. The indicators that used in student's response questionnaire are enthusiasm and the easiness, which each indicators are developed into five statements. The observation sheet use three indicators, which are installation process of the game in computer, operating process of the game, practicality of the game. The indicators are developed into twenty statements to observe students activity during the lesson.

The data analysis of validation sheet has purpose to know the validity of CIHOE game. Student's response questionnaire and observation sheet has purpose to know the practicality of CIHOE game. The percentage can be calculated using formula below:

$$\frac{\text{Total score of validators}}{\text{Maximum score}} \times 100\%$$

Based on the calculated percentage, CIHOE game is stated valid if the percentage is $\geq 61\%$ (Riduwan, 2015). The criteria of the result from data analysis are interpreted based on table below:

Table 2. Criteria of the validity value.

Average score (%)	Criteria
0-20	Really bad
21-40	Bad
41-60	Enough
61-80	Valid
81-100	Very valid

Pretest and posttest are consist of 10 multiple choice questions. Score of each correct answer is one. Pretest given to student in the beginning of the research to measure the initial knowledge about elemental chemistry materials. The classical completeness calculated by formula below:

$$\frac{\text{Number of students passed minimum score}}{\text{Total number of students}} \times 100\%$$

The result of pretest and posttest score are analyzed using Kolmogorov-Smirnov test to see the normality. If the Sig. Kolmogorov-Smirnov shows a value of more than 0.05, it means that the data distribution is normal (Arifin, 2017). In addition, to see the effectiveness of the CIHOE game, the pretest and posttest score are analyzed using Left-Sided One T-Test using SPSS application. Statement of H_0 is score of pretest or posttest are ≥ 70 , while H_a is score of pretest or posttest are < 70 . In the left-sided test, if the T-count value is greater than or equal to the T-table, then H_0 is accepted (Sudjana, 2005).

RESULTS AND DISCUSSION

Teacher's Interview

Based on the interview with one of chemistry teacher in SMAN 1 Menganti, the methods to teach elemental chemistry material is by reading and lecturing. Teacher always use periodic system table. There are no other media that used to explain elemental chemistry material. Students only read the elemental chemistry material by themselves. The teacher requires students to memorize the main group elements and always check the result of the memorizing. The obstacle of explaining elemental chemistry material is lack motivation from students. Most of students have low motivation in learning chemistry. There are several student that did not come to teacher to memorize name of element and its group.

Validity of CIHOE game

CIHOE "Chemistry Island: Heaven Of Elements" game development is using Unity application based on storyboard that have been

arranged. Validation sheets are given to two lecturer and one chemistry teacher. Validation steps are needed to make sure that the game is appropriate to use as media in chemistry learning. There are 12 criteria of the validity such as correctness of learning materials, objectives, natural sciences characteristic, rules, guidance, standard of completeness, student's involvement, feedback, decision-making, media display, software manipulation and audio visual communication.

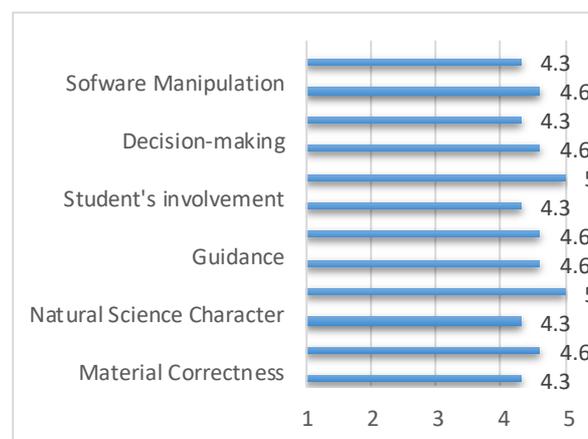


Figure 2. Result of validity of CIHOE game from three validators.

The first aspect is about the correctness of elemental chemistry material. The result of three validators are 87 %. It means that the materials inside the CIHOE game are really valid. The material inside the game are consist of the ore, abundance, preparation process, physical properties, chemical properties and the advantages of main group elements. The second aspect is the objectives of the game. Three validator give percentage 93 %. It means that the objectives inside the game are appropriate with the basic competency of the elemental chemistry material. The natural science characteristic aspect has percentage of 87 %. This characteristic can be seen when the student play the game, they have to classify the main group elements and its properties. The rules of the game has percentage of 100 %. Each level of the game has its own rules. It makes the player easier to understand how to play the game in each level. Besides the rules, the game has guidance in form of guidance book. There are two guidance books, for student and for the chemistry teacher. The validators give percentage 93 % for the guidance aspect. For the standard of completeness, the averages percentage from validators is 93 %. Each level has standard completeness. For example, minimum score of level 1 is 70 to be appointed as complete and player can go to second level.

In the CIHOE game, students have to answer several questions in the each level. This is because researcher wants to maximize the student's involvement in elemental chemistry learning. If student fail to choose the correct answer, the explanation will not appear so that they have to try again to know the correct answer. Validators gives percentage score of 87 % for the student's involvement aspect. If the student choose the right answer, there will be feedback in form of point to increase their score. Furthermore, there are several multiple choice in the game, so students have to make decisions about their answer. Validators give percentage of 100 % for feedback and 93 % for the decision-making aspect.

Game as a media for student, it must be easy to operate. There is a guidance book that can help student install the application on their computer or laptop. Files of the game are easy to send by online or offline procedure. After downloaded, game files can be installed directly and ready to use. The audio visual of the game are appropriate as a chemistry learning media. The background, font and the sound effect are appropriate with the materials. Validators give percentage of 87 % for media display, 93 % for software manipulation and 87 % for audio visual communication aspect.

The suggestion from the teacher is that it will be great if the game can be operated in android version, so students can play it on their phone. Teacher also give suggestion about the second level of the game. Teacher think that it will be so challenged if there is a time limit to play the element ball shooter in the level 2.

Based on the several explanations above, the averages validity of CIHOE "Chemistry Island: Heaven Of Elements" game is 91,25 %. This value indicate that this game is appropriate to use as media in elemental chemistry learning.

Practicality of CIHOE game

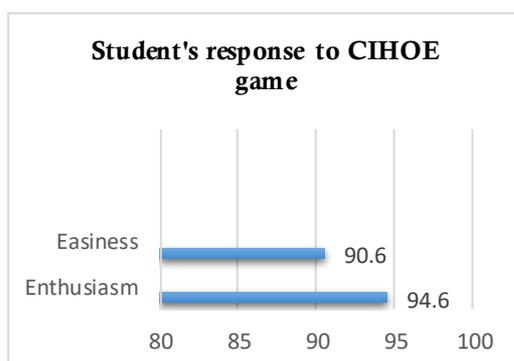


Figure 3. Result from student's response questionnaire.

Practicality of the game can be analyzed through the observation and student's response questionnaire. The response of students for the first statement, which is "CIHOE game make me feel interested and motivated to learn elemental chemistry material", is 100 % yes. This is because in their ages, students are enjoyed playing games. When the learning materials are presented in form of games, students will be interested and motivated. In addition, the minimum score as a requirement to pass the level make student feel more challenged. The average percentages of student's response based on the questionnaire result is 92,6 %. The average percentages of student's activity based on the observation result is 98,57 %. It means that by using this game as media in learning elemental chemistry materials, the learning activities of students are very effective.

An active student involvement in learning activity can maximize the learning process. Based on constructivism learning theory, student involvement can make it easier for students to construct their knowledge. Knowledge is not a gift from the teacher, but the result of the construction process carried out by each individual (Isti'adah, 2020). Through this learning experience students will interpret and easily remember the learning material. Learning chemistry by using game media such as CIHOE can help students have a pleasant experience in learning so that it will be easy to remember the materials.

The theory related to constructivism learning theory is Piaget's theory of cognitive development. Piaget stated that cognitive structures are the result of a child's development process. Senior high school students have an age range of 15-18 years old, which according to Piaget is the formal-operational period. Development level of cognitive structures occurs maximally and adolescents can think logically and also use scientific reasoning (Slavin, 2017). Therefore, students have begun to be able to learn independently which can be maximized by the presence of learning media that can create a pleasant learning experience.

The averages percentage of learning activity during the lesson based on the observation is 98,57 %, stated as very good. Students seems interested and enjoyed the learning activity using CIHOE game as a media. They can focus on playing at their own computer or laptop. When they got bad score in the game, they try again until they got appropriate score to continue the next level. They also communicate each other to discuss about the answer of the difficult question together. It can help them to be more understand about the materials. This is appropriate with the Vygotsky theory about social constructivism learning theory. Constructivism learning activity is based on learning that occurs through the active

involvement of students in the construction of meaning and knowledge (Sugrah, 2019). The learning process become more active by the interaction among students in playing CIHOE game.

Effectiveness of CIHOE game

Effectiveness of the game can be analyzed through the score of test. Based on the result of pretest and posttest, the classical completeness can be calculated. From the data result, there is one student can pass the minimal score of the test in the pretest.

There are two statistics analysis that used to analyze the pretest and posttest result. First is Kolmogorov-Smirnov test to see the normal distribution of data. The second is Left-Sided One T-Test to see the effectiveness of CIHOE game as media in elementals chemistry learning.

One-Sample Kolmogorov-Smirnov Test

		Pretest	Posttest
N		15	15
Normal Parameters ^a	Mean	38.0000	79.3333
	Std. Deviation	15.67528	10.99784
Most Extreme Differences	Absolute	.162	.202
	Positive	.162	.202
	Negative	-.125	-.167
Kolmogorov-Smirnov Z		.627	.782
Asymp. Sig. (2-tailed)		.827	.573

a. Test distribution is Normal.

From the result above, the data of pretest and posttest are distributed normaly. We can see that the value of Sig. Kolmogorov-Smirnov of pretest data is 0.827 while posttest data is 0.575. If the Sig. Kolmogorov-Smirnov shows a value of more than 0.05, it means that the data distribution is normal (Arifin, 2017).

One-Sample Test

Test Value = 70					
t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Post test	3.287	14	.005	9.33333	3.2429 15.4237

From the results of the analysis through the T-test, the T-count value is 3.287 and the T-table value is 1.76. In the left-sided test, if the T-count value is greater than or equal to the T-table, then H₀

is accepted (Sudjana, 2005). The test result shows that the value of 3,287 is greater than 1.76, so H₀ is accepted. This means that the average posttest score of students is more than 70.

After the student treated with the CIHOE game while studying elemental chemistry material, there are 14 student can pass the minimum score in the posttest. It means that classical completeness at the pretest is 13 %, while in the posttest reaches 93 %. This result indicates that after CIHOE game used as a media in elemental chemistry learning, student become more understand about the materials. This finding goes along with the other research in educational field. The uses of game in learning chemistry can affect the completeness of student’s learning outcomes (Hidayah, Suprianto, & Rahmawati, 2017). The score of students in pretest and posttest is increase after they learning periodical system of elements materials using game-based learning media called “Kimia Kotak Katik”.

The effectiveness of the CIHOE game "Chemistry Island: Heaven Of Elements" can be explained using information processing theory. An important component in learning is the organization of the information learned, the previous knowledge that students have mastered, and there are processes that involve understanding, meaning, storing and retrieving information (Hasanuddin, 2017). When the student play the CIHOE "Chemistry Island: Heaven Of Elements" game, there are processes that involves understanding, meaning, storing and retrieving information. Therefore, it is easier for students to understand and remember about elemental chemistry material.

CIHOE "Chemistry Island: Heaven Of Elements" game also take several example of elementals chemistry in daily life. It has purpose to associated the materials with the daily life aspect. One of the learning objectives in this game for elemental chemistry material is knowing the uses and benefits of the elements in level 1 and 3. Students will choose the correct elements based on the characteristic and uses of the elements in daily life. Game was proven effective in improving students’ creative thinking skills. The students acquired the skill through observation, active interaction with the characters, performing repetitious experiments and interpreting the main part of the games associated with environmental effect in real life (Putra & Iqbal, 2016).

The second level in the CIHOE game has main purpose to strengthen the student’s memory about main group elements and its group. Student have to shoot the element ball based on their correct group to get scores. This step will help them to memorize the symbol of elements and its group. If the score is minus, they have to play again the elements ball shooter. This

repetition is helpful for student to memorize the main group elements. They will not feel bored in learning elemental chemistry material.



Figure 4. Elements ball shooter in level 2 of CIHOE.

It was generally agreed that a very important reason why game have a positive effect on learning is because games provide live experience of user involvement (Cheng, Chen, & Chen, 2015). By playing CIHOE game, students as the user are focus individually on their laptop or computer to complete the missions. This can make them experienced all the challenge and questions in each level. It can make positive effect to their learning process. Based on the one of research in developing learning media, the use of Chemmo Configuration game in chemistry learning can improve learning outcomes and student motivation (Lutfi, Hidayah, & Qona'atun Muslela, 2019). After the student use the media, they felt more understand about configuration electrons. The classical completeness also increase from pretest to posttest. This is because the game also include several questions based on the learning objectives and basic competency that can help student to answer the test.

Students felt that it was easier to understand lesson because the lesson was delivered not only through text, but also picture, audio, video and animation. The game in interactive media make the student be entertained and active in learning process (Saputri, Rukayah, & Indriayu, 2018). The findings support the results of research proving that the integration and implementation of computer games into the classroom can help students study more fun and effectively. The use of games in learning can make the student's activity during the learning process is more active and also increase their knowledge compared to conventional classes (Papadakis, Trampas, Barianos, Kalogiannakis, & Vidakis, 2020).

The other benefit of game-based learning is the joyful situation while students learning. Students

thought the game based learning activities were more enjoyable and interesting (Jin, Tu, Kim, Heffron, & White, 2018). If the situation of learning activity is enjoyable, students will become motivated and want to learn more about the lesson. The high motivation of students in learning can maximize their learning outcomes.

Using game-based learning method can be great option for teacher to manage a lesson. The success or failure of a lesson depends on the management carried out by the teacher. If the teaching method is effective, the learning objectives of lesson will be reached easily. The conventional method that applied by chemistry teacher in reality is less effective and cannot reach the learning outcomes that expected based on basic competency. It is because conventional methods are monotonous and student less active during the lesson.

Based on "freedom of learning" issue in educational aspect, student can learn everywhere and every time despite of learning in the classroom. Game-based learning can be one of option to make student's learning activity become optimum. They can learn elemental chemistry material independently in their home using CIHOE game. CIHOE game also has guidance book so that students can operate the game by their self. Guidance book of CIHOE can help them from the installing process of the game. CIHOE game can help student to understand the elemental chemistry material, even though they learn independently.

As a teacher, we must keep abreast of technological developments. The technological developments have advantages especially in the development of learning media. In the future three-dimensional, interactive, multi-user, collaborative virtual environments (based on computer games technology) are going to be increasingly used to generate online educational experiences around the world (Schofield, 2018). By using game as a learning media, the situation of chemistry lesson become more interesting and fun. Students will feel motivated and not bored during the lesson. The use of game as a media in educational aspect have to be more implemented.

CONCLUSION

From the result and the data analysis, CIHOE game is appropriate to use as a learning media in elemental chemistry material. The averages validity value of CIHOE "Chemistry Island: Heaven Of Elements" game is 91,25 %. This value indicate that this game is proper to use as media in elemental chemistry learning. The practicality value of CIHOE "Chemistry Island:

Heaven Of Elements" game is 92,6 %, which means very easy to operate and useful. The observation result of the student's learning activity reaches 98,57 %. It means that by using this game as media in learning elemental chemistry materials, the learning activities of students are very active. The classical completeness at the pretest is 13 %, while in the posttest reaches 93 %. It means that CIHOE game is very effective to be used as a learning media in elemental chemistry material. Game have several good impact on learning process. It is necessary for teachers to know that they can use game as a learning media. The use of game as a media in educational aspect have to be more implemented.

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