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Development an Android-Based Game "Chemical Hydro Adventure" for Learning Hydrocarbon Material

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Abstract

This research aimed to develop an Android-based Game named Chemical Hydro Adventure as media learning of hydrocarbon materials to improve learning outcomes and quality. This research used Research and Development (R&D) methods within three aspects assessed: validation by the experts, the practicality of the game based on students' questionnaire results distribution, and the game's effectiveness based on improving learning outcomes. The results showed 86.13% highly relevant, meaning that the game media was suitable to validity criteria, thus, it could be tried and tested. The practical results obtained 94% very practical, meaning the game could facilitate the students to learn hydrocarbon materials. In addition, there were significant effects of the game reaching minimum completeness, meaning the game was a very effective tool. Therefore, the game developed was reasonable to be use and it was expected chemistry teachers could apply and use it properly. Furthermore, it could facilitate the chemistry teaching and learning process of hydrocarbon materials.

1. INTRODUCTION

Teachers are expected to understand and know their students well and can increase the creativity of their students, especially when selecting learning media. Recent findings about technology and pedagogy not only support the emergence of new educational innovations but also challenge teachers as they must decide whether to implement them (Lutfi & Hidayah, 2021). Therefore, new ideas must be emerged from students thinking ability through their self-development, and scientific approaches to developing the learning of education (Sani, 2013). Advantages of applying the usage of technology in carrying out learning in the classroom.

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Thus, students will gain creativity, productivity, critical thinking, independence, collaboration, and communication by creating new ideas or concepts (Permendikbud, 2018).

A science that studies the properties, composition, structure, and modification of matter is called chemistry (Arista, 2014). Many students think that chemistry is a fairly complex subject. In the Johnstone et al. (2014) test, an important factor that students need to understand is that chemistry has complex and varied chemical elements. This is because thoughts of chemistry are often difficult and confusing, and it also requires scientific explanation in which a high level of reasoning knowledge is needed (Sari, 2014). Thus, it makes chemistry difficult to learn. At the same time, students lose interest, get bored, feel lazy, and dislike this subject, especially while studying hydrocarbon materials. When students study hydrocarbon material and try some practice questions, they cannot finish them well. Therefore, students will be more excited if they received interesting learning, such as playing games on their mobile phones with the addition of hydrocarbon material in it.

Students cannot solve questions well when practicing some questions on hydrocarbon material. Therefore, a topic that can develop the student's knowledge is taken in accordance with the Hydrocarbon Chemistry material in the 11th grade, which is according to Basic Competencies (KD) 3.1 Examining the structure and composition of hydrocarbon compounds based on their atomic groups and characteristics of carbon. Carbon is a compound that is contained in Hydrocarbons. However, it can also contain other atoms, such as hydrogen (H), nitrogen (N), oxygen (O), and other organic substances.

The background in this study based on survey. Questionnaires are distributed to students at SMA Negeri 1 Menganti, Gresik, and SMA Negeri 12 Surabaya. Also, interviews are conducted with some teachers about the material learning they do not like, and their opinions about the learning media used. The results showed that 77% of students use textbooks, 23% use Microsoft PowerPoint in their learning process. And it was found that 60% of students were not interested in studying chemistry on the grounds that students lost interest, were bored, lazy and did not like the subject. so to improve students' understanding, special interactive learning media is needed on the Hydrocarbon material.

One of the interactive learning media that can be used by teachers is the Android mobile application, which is very useful for increasing learning outcomes, bringing joyful, and increasing the knowledge of students. In accordance with the research by Alfiriani et al. (2022), nowadays, the usage of Android-based smartphone devices for students is a very useful necessity. Thus, this can be a good consideration for some slow learners. The use of games in learning have been proven to improve learning outcomes in studying several chemistry topics, such as acids and bases, chemical elements, and hydrocarbons (Lutfi et al., 2019).

Based on the questionnaire distributed to students, 87.5% of students stated that they like playing games, 52% were adventure games, 26% were trivia and 22% were racing. Upper-level students were youth category that still enjoyed to playing traditional and online games. On average, 80% of students were between the ages of 12-21 (Agate Studio, 2012).

According to Lutfi and Rusly (2021), the use of computer games is very effective in helping students learn and reach the minimum completeness target with significant test results. In research by Oliver (2018), the implementations of the usage of technology in education or gamification that deserve to be developed are the appearance, how to use, ease of access, interesting music background, increase of the difficulties of each level, the game, and its features and a fun time. Therefore, the development of the game is declared highly relevant or valid. Rusdi (2016) also stated that the Android-based learning media of "ChemBird" in chemistry lessons is feasible to use. In addition, according to Fatimah (2016), Android-based game media is very suitable to be used and appropriate in learning.

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Therefore, in this study, an Android game is designed to contain learning materials about chemistry, especially hydrocarbons. Nowadays students cannot be separated from their phone cellular. Thus, how the way to play the game is easy and also can be played anywhere, and not burdensome. In the same way, students also like to waste their time playing games. This game will provide a holistic experience and help students improve skills, and learning outcomes, overcome stressful situations, and motivate students to be fully involved in the learning process, and also become creative students. Research by Al-Mira (2020) pointed out that an Android game can improve student learning outcomes. This Android application combines text, multimedia, audio, video, graphics, and animation so that the student learning styles are completely different due to the useful media.

This Android application is highly necessary for learning chemistry; however, it is not yet available. Therefore, we develop an Android-based game 'Chemical Hydro Adventure' to help students in learning hydrocarbon materials. Then, it can be studied with innovations in the learning process. Previously, it is only a standard game that is only played generally. The purpose of this study is to obtain the feasibility of game media as an educational tool for students. As a result of the game development, chemistry teachers can use this game media well and make this game become meaningful learning in their learning process.

2. METHOD

Research by Aulya et al. (2021) develop a game using the Borg and Gall research and development (R&D) method as a research design. This R&D model also refers to the process of designing and validating educational media (Priscylio et al., 2020). This method is the best way to improve and acquire new knowledge about research methods using some infrastructure to improve learning outcomes. There are 10 steps of the Borg and Gall Research and Development method, namely:

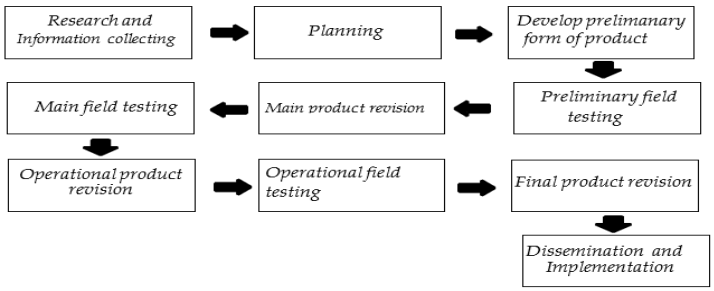

Figure 1. Research and Development Steps

Test and trial product research were located at the SMA Negeri 1 Menganti, Gresik. Research contained XI IPA 5 grade within 30 students as the research target. The target and location were selected because of the teaching experience in the class. Meanwhile, this development was only conducted until the Main Product Revision steps. The data collection instruments required were:

a. Game validation sheets were administered to the two chemistry lecturers according to their expert of media and experts of content as well as a chemistry teacher because of its compatibility with the criteria to become some media and content experts. These experts understand well about media learning, have good creativity to make lively discussions in the classroom, and then also like to make some media content modifications. Its purpose was to assemble some assessment data and opinions about the feasibility of chemistry games, based on material components, language, presentation criteria, and congruence with its mind

mapping criteria outcomes. The data analysis was a quantitative descriptive method, then could be obtained total score by a validator with a Likert scale (Table 1). Percentage above 60% with valid criteria for the product being developed (Riduwan, 2015).

Table 1. Category of Score Interpretation based on Likert Scale.

Percentage (%)	Criteria
0% - 20%	Invalid
21% – 40%	Not valid
41% - 60%	Quite valid
61% – 80%	Valid
81% - 100%	Very valid

(Riduwan, 2015)

b. Response questionnaire sheets from 30 students during the testing of the game aimed to determine the practicality of this game. The questionnaire contained some aspects showing students' interest in the game. By using this way, it can be known whether this game can be considered a practical one or not. Results of the practicality test are also interpreted based on Table 2. It is named 'practical' when it reaches a percentage above or equal to 61% of the product (Riduwan, 2015).

Table 2. Criteria for Interpretation of Scores based on a Likert Scale.

Percentage (%)	Criteria
0% - 20%	Impractical
21% – 40%	less practical
41% - 60%	quite practical
61% – 80%	practical
81% - 100%	very practical

(Riduwan, 2015)

c. Student learning outcomes sheets, total score before using (pre-test), and total score after using the game (post-test) (Sugiyono, 2015). The effectiveness test was analyzed by students learning outcomes, if only they had mastered some indicators or educational goals with a set of criteria by their school, and whether fulfilled the minimum completeness target of 75 for chemistry subjects by conducting a pretest and posttest. Then the use of the Kolmogorov-Smirnov normality test from IBM SPSS Statistics v.20 showed > 0.05 for normal data distribution (Copriady et al., 2020). The Kolmogorov-Smirnov Normality test is a simple common usage and not contains any perception. After being normally distributed, the increase of student learning scores is calculated by formula as the value of the n-gain as follows:

$$g = \frac{Sposttest - Spretest}{Smax - Spretest} \quad \text{.......................................(1)}$$

Information:

$S_{posttest}$ = post-test score students.
$S_{pretest}$ = pre-test score students.
S_{max} = maximum score obtained.

Then obtained categories such as Table 3. below (Hake, 1998).

Table 3. Criteria Score N-gain

Percentage (%)	Criteria
g ≥ 0.7	Tall
0.7 > g ≥ 0.3	Currently
g < 0.3	Low

(Hake, 1998)

According to the criteria, the scores are interpreted to the following Percentage of Interpretation in Table 4. (Hake, 1998).

According to the percentage of interpretation N-Gain Score which is more than or equal to 56%, the product is quite effective with an average 0.3 N-gain score in the medium to high categories.

Tabel 4. Tafsir of Interpretation for Score N-gain

Percentage (%)	Tafsir
<40	Ineffective
40-55	Less effective
56-75	Effective enough
>76	Effective

(Hake, 1998)

Based on the analysis results, a standardized test of the pre-test and post-test scores were combined with a Paired Sample T-Test to separate the 2 distributed data sets. This T-test also used the IBM SPSS Statistics v.20 application aiming to test the emerging hypotheses. Decisions in the results of this T-test are determined by the value of Sig.(2-tailed), while the score can be assumed if only the significance score > 0.05, H_0 is accepted. But if the significant score < 0.05, H_0 is declined and H_1 is accepted by using a comparison between the numbers and tables, by taking 95% (α = 0.05) with a degree of freedom df=n-1, so if $t_{count} > t_{table}$, then Ho is declined, while if $t_{count} < t_{table}$ then H_0 is accepted (Hati & Novita, 2018).

3. RESULTS AND DISCUSSION

Developing this Android-based game, namely Chemical Hydro Adventure with Hydrocarbons materials, results obtained from each step were:

Research Data Collection

Research Data Collection is extremely essential for understanding student needs about these products. Some data collection was collected through field and library research.

Field assessments were conducted using the curriculum and many resources related to the designing and testing of Android-based game media. To achieve this goal, we analyzed the educational curriculum of 2013 about its core and basic competencies. The results of the questionnaire and interview process for students and teachers were analyzed. The results of the student questionnaire who has not ever used an Android-based game about chemical learning yet, especially hydrocarbon materials. Interview processes with teachers showed that the teaching materials they used are only textbooks, so their students have difficulties understanding the materials. In addition, hydrocarbons have much relevance to other important knowledge, so it is in accordance with the criteria of the game being developed.

Planning Steps

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Planning steps were carried out by adjusting it, which consisted of cover, core competencies, basic competencies, indicators in learning, learning core competency standards, and basic competencies properly, and a syllabus based on the 2013 curriculum. The product of this research was an Android-based game Chemical Hydro Adventure of Hydrocarbons materials which was studied by XI grader at KD 3.1. Components of this product consist of three parts: (l) Introduction objectives, introduction of games with brief descriptions, (2) Content section which consisting of the game display menu in the form of new games, continue, settings, developer profile, and exit steps. This game has 3 different levels in the game that are adjusted to each level of material and level of difficulty of the questions, namely: stage 1: alkane compounds, stage 2: alkene compounds, and stage 3: alkyne compounds, and 3) the closing section contained questions and a bibliography.

Development of Preliminary Form of Products Steps

After product planning was conducted, the next step was product draft development. Parts of this are:

The introductory section consists of a cover, introduction, core competencies, basic competencies, indicators in learning, learning objectives, and game instructions. The front cover is designed to display a university logo and then will appear a nature background that relates to the many hydrocarbons in nature and shows themes from the adventure category games. There is a "New Game" menu, button to start the game; "Continue" button to continue a saved game; "Option" button to adjust the volume of the game; "Credits" button to know the game creator profile; and "Exit" button to exit the game (Fig.2.). Start the game will appear introduction of the game by entering the name, Core Competence, Basic Competence, indicators in learning, learning objectives, and playing instructions.

The content section contains 3 levels of stages in learning, level 1: alkane compounds, level 2: alkene compounds, and level 3: alkyne compounds. At each level, sub-materials, basic competencies, indicators, and learning objectives are provided.

The closing section consists of questions of understanding and a bibliography.

During the product draft development steps, researchers produced an Android-based game, namely Chemical Hydro Adventure about Hydrocarbons materials. The materials had been revised and given some benefit input by Android experts, which were: media design and learning materials experts.

Figure 2. Display of the game developed

The educational materials created by the researchers were reviewed and explained about the form of the Android Chemical Hydro Adventure-based application. Then this application was validated by multimedia and learning materials design experts: chemistry education lecturers and chemistry teachers.Thus, feedback and product improvement recommendations can be developed about the validity of suitability of material, reliability, language, presentation criteria, and structured thinking from experts' input and suggestion (Fibonacci et al., 2020). The estimated reliability of the game was 86.13% by experts, then interpreted in Table 1. with a "highly relevant" percentage range (Table 1). These results indicate that the game meets the validity criteria, meaning that the contents of the game material are

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correct and the requirements as hydrocarbon learning media have been fulfilled. The developmental testing step in this research is only at the initial testing section, namely, the trials are limited to students.

Preliminary Field-Testing Steps

Game Practical Analysis

Determined the practicality of the media, data was collected in form of a student response questionnaire. In distributing questionnaires, the number of 'yes' answers obtained with respondents of as many as 30 students was 94% and then interpreted into an assessment table in Very Practical Category (Table 2.) This indicates that this game improves the quality of learning and that students understand hydrocarbon material. This Android-based Chemical Hydro Adventure game media shows that it is very practical to be used and processed because the game has a large capacity. Although the students play the game a bit slowly, even so, this game makes it very easy for students to learn hydrocarbon material.

Game Effectiveness Analysis

This analysis aims to determine the effectiveness of Chemical Hydro Adventure in analyzing the results of student evaluations. Students are said to have completed their studies well if they only master a minimum standard of 75 in Chemistry. The pre-test questions are designed to determine the student's initial abilities before receiving new treatment in using this game. The post-tests are intended to determine the student's final ability after treatment. Both pre-test and post-test are used to assess the success level of learning outcomes when using the game. Learning activities are declared effective if only students achieve minimum completeness and respond positively to this section (Lutfi, et al., 2021). This test is carried out without any comparison, which is a controlled group that allows for a more accurate representation of the results.

An amount of 0.854 or a percentage of 85.4% of 30 students was obtained by the N-Gain score, then interpreted at the N-Gain Score Criteria table as a high criterion. Based on the analysis results, Chemical Hydro Adventure will effective if the student's knowledge and abilities increase, and reach an N-gain score>0.7 (Table 3.) with a percentage of interpretation> 76% (Table 4.).

At first, the pre-test and post-test scores of the Kolmogorov-Smirnov normality test were conducted and the results obtained in Table 5.

Table 5. Kolmogorov-Smirnov. Normality Test

Tests of Normality

	Kolmogorov-Smirnov [a]		
	Statistics	df	Sig.
Pre-Test	.130	30	.200 *
Post-Test	.130	30	.200 *

Table 5 shows Sig.>0.05, meaning the distribution is normal and Sig.<0.05 tends not to be normally distributed. Based on the normality test, it is also known that a significance value of 0.200 means Sig. score>0.05 which means normally distributed. The results are processed using the T-test (Paired Samples T-Test), whereas the T-test condition for related samples are the differences between the two data sets in a normal distribution. The t-test was obtained with IBM SPSS Statistics v.20. This test is conducted to confirm the established hypothesis, namely:

H_0 = Chemical Hydro Adventure is not used effectively.

H_1 = Chemical Hydro Adventure is used effectively.

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Table 6. Paired Samples T-Test

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-Test – Post Test	-60.167	10.042	1.833	-63.916	-56.417	-32.818	29	.000

The results of the Paired Sample T-test (Table 6.) show any significant changes in the paired sample. The results of the T-test are determined by the significance score of the Paired T-test. According to the results, it can be concluded that H_0 is rejected and H_1 was accepted because the significance score is 0.000<0.05, so there are any average differences between learning outcomes before and after the tests, which also meant there is a significant effect on student learning outcomes through playing. Chemical Hydro Adventure games is certainly effective to improve learning outcomes. Mastery of learning outcomes is presented in Figure 3 and improved learning outcomes is in Figure 4.

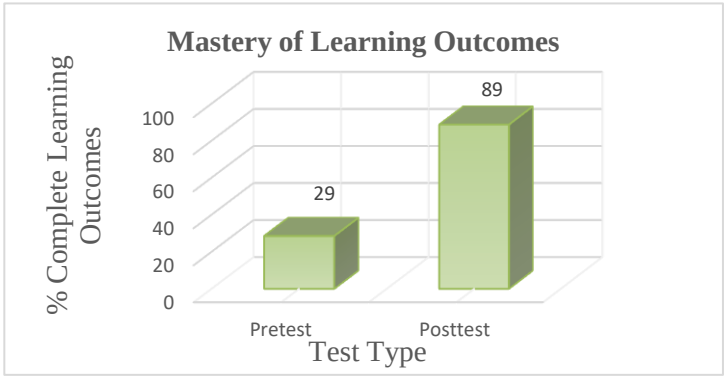

Figure 3. Mastery of Learning Outcomes

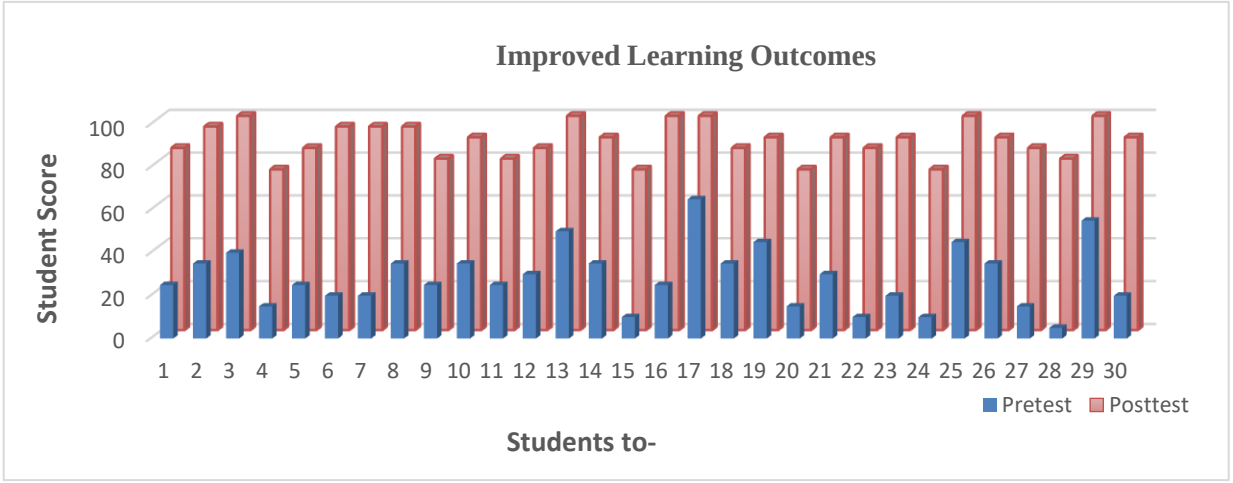

Figure 4. Improved Learning Outcomes

These results are appropriate well with this current research (Marpaung & Pongkendek, 2020) showing both animation video, and audiovisuals in learning media can increase understanding, and build the imagination, and also creativity of students.

Main Product Revision Steps

This step is conducted to produce a final product, which is an Android-based Game Chemical Hydro Adventure with Hydrocarbon materials. After conducting several variations of validation tests by some experts and practical tests by students, the results of the validation test and response are all excellent with several suggestions for the resulting product in the form of a smaller memory capacity simplification, and the Android-based game media repair is appropriate to some expert's judgment. Finally, this game media can be used well by educators in the learning process in their classroom.

4. CONCLUSION

In the development of the Android game "Chemical Hydro Adventure" as a Learning Media for XI grade high school students on Hydrocarbons Material, the data generated was used to comprehend the validity of the game and the results were highly relevant, meaning the game media had fulfilled the components of the validity criteria. This indicated that the material components were highly correct and suitable to be used and all requirements of hydrocarbon learning materials had been fulfilled well.

Regarding the practicality of the game, it obtained very practical criteria for using the game. Students could easily understand hydrocarbon materials because of this game. Then the game could improve student learning outcomes, which had reached a minimum completeness score after playing this, while game development was very effective in being used. It can also be concluded that the game developed was suitable for use and it was expected that chemistry teachers could apply and use it easily, then could facilitate the teaching and learning process of hydrocarbons in chemistry.

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