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Development of FUNCHEM Educational Game Based on Integrated Chemo Edutainment Ability Critical Thinking Skills of High School Students on Colloid Material

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ABSTRACT

The research aims to develop the funchem educational game based on a chemo-edutainment approach integrated with critical thinking skills as an instructional medium for the topic of colloids. The research was driven by the low level of students critical understanding of colloidal concepts and the prevalent use of conventional teaching methods that tend to be monotonous. The chemo-edutainment approach, which merges educational content with entertaining elements, is considered to have the potential to create a more engaging and enjoyable learning experience. The research employed a Research and Development (R&D) design, adopting the Lee and Owens model, which encompasses five systematic phases: Analysis, Design, Development, Implementation, and Evaluation. The findings of this study indicate that: (1) the development process of the educational game involved a series of steps including needs analysis, media design, product development, and classroom implementation; (2) expert validation results from both content and media reviewers categorized the game as "Excellent" and highly appropriate for use in the classroom; and (3) teacher assessments and student responses demonstrated high levels of enthusiasm, with the majority of students reporting that the game significantly supported their understanding of colloidal concepts. In conclusion, the chemo-edutainment-based educational game integrated with critical thinking skills has proven to be effective in enhancing students' critical thinking abilities within the context of colloid instruction.

Keywords: Chemo-edutaiment, Colloid, Educational Game

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1. INTRODUCTION

Education is important for every individual to develop knowledge and skills. In accordance with Law No. 20 of 2003, education aims to develop the potential of students actively. The success of learning is highly dependent on the role of the teacher who is able to create a learning atmosphere that motivates and encourages students to think critically. One of the supporting factors is learning media.

Learning media is a tool that is able to channel information and stimulate students' thoughts and attention, so that it can improve the teaching and learning process (Miharti, 2022). Students are presented with learning problems, where the main focus is not on the answers but on how they arrive at those answers (Sudiantini & Shinta, 2018). In the Merdeka Curriculum, learning emphasizes the process, encouraging students to think critically, creatively, and independently. High school chemistry is considered difficult because of its abstract nature (Ristiyani & Bahriah, 2016). However it can be contextualized through material that is close to life, such as colloids. This material is relevant because it is found in everyday life and can be used to develop students' critical thinking skills through experimentation and data analysis.

Critical thinking is an intellectual process involving the formulation, application, synthesis, and evaluation of information from observation, experience, or communication as a basis for action (Lismaya, 2020). According to Piaget, elementary students are in the concrete operational stage, where they think using real objects or problems (Rosidah, 2018). Thus, highly motivated students tend to think more critically. Therefore, critical thinking skills should be fostered in learning to help students solve problems effectively.Critical thinking is part of the 21st century skills (4C) formulated by the Framework Partnership of 21st Century Skills, namely: 1) Communication, 2) Collaboration, 3) Critical Thinking and Problem Solving, and 4) Creative and Innovative or inventiveness and innovation (Mardhiyah, 2021). which is important to be familiarized with in learning. Based on the results of the analysis of student needs in class XII SMA 1 Muaro Jambi, the students who filled in the respondents,

totaling 26 students, stated that around 99% of students had smartphones. As many as 96.2% of students like digital learning media such as PPT, learning videos, learning websites and others. As many as 84.6% of students have problems in understanding chemistry material, and as many as 77% of students agree that colloidal material is quite difficult to understand. And 88.4% of students are interested in understanding colloidal material by understanding the learning concepts applied in using educational games.

Based on the results of observations made by researchers with one of the chemistry teachers at one of the SMA 1 Muaro Jambi schools, it was stated that the curriculum used in a class X, XI, and XII learning was the independent curriculum. Then the learning process on certain chemistry materials many teachers still use traditional learning methods such as lectures or group discussions without involving activities that stimulate creativity. This method often lacks challenging students to think outside standard boundaries or explore new ideas. On the other hand for learning media, school learning relies on conventional learning media, such as LKS or LKPD, and some interactive media but not too often so it tends not to stimulate students to think critically enough. According to the Chemistry Teacher of SMA 1 Muaro Jambi, the use of interactive multimedia in the form of educational games on colloidal material has never been done before. In this school, the Criteria for Achieving Learning Objectives (KKTP) that students must achieve in this chemistry subject is 80. During the learning process, the researcher analyzed that in colloidal material, most students were able to achieve quite good test scores, where around 70% of students could answer the questions correctly. However, although the test results showed adequate understanding of the colloid concept, students critical thinking skills were still low.

According to the Chemistry Teacher of SMA 1 Muaro Jambi, students tend to have difficulty when faced with problems that require in-depth analysis, application of concepts in new situations, or solving more complex problems. Students have not been able to connect colloid concepts with everyday phenomena critically or solve problems that require them to think outside the context that has been taught. This shows a gap between the understanding of basic concepts and students' critical thinking skills but during the colloid learning process in the classroom, the activities carried out by students have not encouraged their creativity or only focus on memorization and direct understanding of concepts. Students only repeat information without being given the opportunity for creative exploration, this indicates a lack of development of creative thinking skills. And school facilities such as laboratories and computer rooms are available but have not been optimally utilized in learning.

Considering some of these problems, the most appropriate solution to overcome students difficulties in understanding and improving critical thinking skills in studying colloids is to use learning media in the form of educational games that can be accessed by users, so they can continue the learning process as needed. Therefore, the use of educational games is very important to facilitate students in understanding learning materials, because this media combines audiovisuals that can influence thinking skills through active interaction. Educational games also support teachers in creating interesting learning, according to the demands of the Industrial Age 4.0 and Society 5.0 (Zurweni, 2024). According to Widiastuti (2012), educational games are digital games designed to support teaching by utilizing interactive multimedia technology. This game not only makes learning more interesting, but also improves students' critical thinking skills. As technology develops, learning media are increasingly diverse, helping teachers teach more effectively and encouraging students to think critically. Chemo-edutainment-based games can support students' learning both independently and in the classroom (Narestifuri & Hidayah, 2022).

Previous research Rasyid (2019) shows that educational game-based learning media effectively improves students' critical thinking skills. Based on these problems, it is necessary to conduct a study entitled **"Development of Chemo-edutainment Based FunChem Educational Game Integrated with Critical Thinking Ability of High School Students on Colloid Material".**

2. RESEARCH METHOD

The type of research conducted is development research or Research and Development (R&D) which produces products in the form of Chemo-edutainment based funchem educational games integrated with students critical thinking skills on colloidal material. The development model used in this research is the Lee & Owens (2004) development model. This model has five stages, namely analysis, design, development, implementation, and evaluation.

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1. Analysis: At this stage the researchers analyzed the learning problems at SMA 1 Muaro Jambi. There are five analyzes carried out, namely (a) needs analysis, (b) analysis of student characteristics, (c) analysis of objectives, (d) analysis of materials, (e) analysis of educational technology.
students, (c) goal analysis, (d) material analysis, (e) educational technology analysis.
2. Design: After the analysis stage is completed, the next step is product design. In planning this research, the next step is to make a product design that will be developed into learning media in the form of a chemo-edutaiment-based funchem educational game product integrated with critical thinking, which will be applied to colloid material. Product design design
development of this media is described as follows. (a) Team Formation, (b) Research Schedule, (c) Media Specifications (d) Material Structure, (e) Flowchart Making (f) Storyboard Making (g) Evaluation.
3. Development: At the development stage, including: (a) Product manufacturing, (b) Material expert validation, (c) Media expert validation, (d) Teacher assessment.
4. Implementation: At this stage, the product that has been improved and declared feasible by the expert team will be tested on a small group of 10 participants and will be tested on a one to one of 3 participants to obtain data on the quality of learning media. The sample selection is based on the recommendation of the chemistry teacher.
5. Evaluation: The evaluation stage was conducted to assess the extent to which the chemo-edutainment-based funchem educational game developed successfully achieved the objectives and met expectations.

After the data is collected, the next step is to analyze the assessment results from the initial analysis questionnaire, material expert validation questionnaire, media expert validation questionnaire, teacher assessment questionnaire, and student response questionnaire.

1. Validation questionnaire for media experts, material experts, and teacher assessments

Data analysis conducted for the validation questionnaire for media experts, material experts, and teacher assessments includes quantitative data, and qualitative data in the form of suggestions or comments. The determination of the validation classification by experts and teacher assessments uses interval distances on a Likert scale using the following formula.

$$\%\ \mathbf{S}\text{core} = \frac{\text{Number of Scores Obtained}}{\text{Total Score}}\ \mathbf{x\ 100}\%$$

Table 1. Assessment Criteria of Experts and Teachers

Number of Item	Average Answer Score	Description of Criteria
1	81%-100%	Very Good
2	61%-80%	Good
3	41%-60%	Not Good
4	21%-40%	Bad
5	0%-20%	Very Bad

2. Student questionnaire

The data analysis technique used for the student questionnaire instrument is by using the percentage of media feasibility. The instrument data that has been collected is then analyzed to calculate the percentage that provides responses according to certain criteria. Ridwan (2015) states that the following formula can be used to categorize student responses.

$$\mathbf{K} = \frac{\mathbf{F}}{\mathbf{N\ x\ I\ x\ R}}\ \mathbf{x\ 100}\%$$

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Description:
K = Percentage of eligibility value
F = Number of respondents' answers
N = Highest score in the questionnaire
I = Number of questions in the questionnaire
R = Number of respondents

Table 2. Student Questionnaire Assessment Categories

Number of Item	Average Answer Score	Description of Criteria
1	81%-100%	Very Good
2	61%-80%	Good
3	41%-60%	Not Good
4	21%-40%	Bad
5	0%-20%	Very Bad

3. RESULTS AND DISCUSSION

Research Result

The first validation from the material expert resulted in a total score of 35 with an average of 2.9, corresponding to a feasibility percentage of 58.3%, classified as "Not Feasible." The expert suggested adding more detailed material, especially on the properties of colloids and their practical uses, as well as improving the clarity of critical thinking questions. Based on this, the first validation was deemed unfit for testing. The second validation received a score of 45, with an average of 3.7 and a feasibility percentage of 75%, classified as "Good." The expert confirmed the material clarity was improved, and the second validation was deemed suitable for testing without further revisions.

Table 3. Result of Material Expert Validation

Validation Stages	Validation 1	Validation 2
Total score	35	45
Average score	2,9	3,7
Percentage	58,3%	75%
Category	Less Worthy	Worthy

The first media validation resulted in a score of 43 with an average of 2.86 and a feasibility percentage of 57.3%, falling into the "Not Feasible" category. Suggestions included improving the template colors, buttons, and the alignment of learning outcomes and objectives. Therefore, the first validation was deemed not ready for testing. In the second validation, a score of 55 with an average of 3.67 and a feasibility percentage of 73.3% was obtained, falling into the "Feasible" category. Additional suggestions included adding icons to the game and checking the alignment of questions with learning outcomes. The second validation was considered ready for testing.

Table 4. Result of Media Expert Validation

Validation Stages	Validation 1	Validation 2
Total score	43	55
Average score	2,86	3,67
Percentage	57,3%	73,3%
Category	Less Worthy	Worthy

Based on the teacher's assessment, the game-based educational media scored 39 with an average of 3.54 and a feasibility percentage of 70.9%, placing it in the "Feasible" category. The teacher found

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the media engaging, challenging, and effective in encouraging critical thinking. The teacher approved the product for testing with students at SMAN 1 Muaro Jambi.

Table 5. Result of Teacher Assesment

Validation Stages	Result
Total score	39
Average score	3,54
Percentage	70,9%
Category	Worthy

Based on the student response data, the percentage of correct answers from all students is 86.6%, which falls into the "Very Good" category (range 81%-100%). There were 3 respondents with a total of 260 answers from 10 questions.

Table 6. Result of Small Group Trial

Validation Stages	Result
Total score	260
Average score	86,6
Percentage	86,6%
Category	Very Good

Based on the small group trial data, the average percentage is 92.6%, falling in the "Very Good" category (81%-100%), indicating that the game is engaging and effective for learning colloid material and is practically feasible.

Table 7. Result of One to One Trial

Validation Stages	Result
Total score	463
Average score	92,6
Percentage	92,6%
Category	Very Good

Based on the results of the development of the Funchem educational game product, the following is a description of the game product that has been developed.



Fig 1. Funchem Colloid Educational Game Layout

The final stage is evaluation, which aims to assess whether the product meets the initial expectations. In this research, the evaluation is formative, conducted at each stage, including analysis, design, development, and implementation. This evaluation helps address any shortcomings identified

in the FunChem educational game based on chemo-edutainment, ensuring it becomes more effective and appropriate.

Discuccion

This research aims to develop a chemistry educational game based on chemo-edutainment integrated with critical thinking skills on colloid material. This research was conducted because colloid learning is still theoretical and lacks stimulation of students' critical thinking, even though most students already understand the basic concepts. The learning media used are also not yet interactive, so innovation in the form of an educational game is needed to increase student engagement and enhance higher-order thinking skills. One of the media that can be used to hone brain skills is games. In this case, by overcoming conflicts or problems within the game, the brain becomes accustomed to actively thinking to solve problems in the game. Problems become more interesting to solve when taken from real life and combined with elements of imagination (Martono Kurniawan, 2011).

A research conducted by Devi et al. (2022) titled "Development of Kolopoli Educational Game Media Based on Android on Colloid System Material" showed that the developed educational game was categorized as very good and deemed theoretically feasible. Rasyid et al. (2019) developed an Educational Game rated very good and feasible, effectively enhancing students critical thinking similar to this study's focus. The research conducted by Damarjati & Miatun (2021) titled “Development of Android-Based Educational Game as a Learning Media Oriented Towards Critical Thinking Skills” showed that the developed educational game was categorized as very good, deemed theoretically feasible, and capable of enhancing critical thinking skills. This reason strengthens the researcher's decision to use educational game media. The use of educational games is the right solution to support a more interactive and enjoyable learning process, as well as being effective in improving understanding of colloid system material.

4. CONCLUSION

The results of the research indicate that the development of the FunChem educational game based on chemo-edutainment, integrated with critical thinking skills on colloid material, has successfully enhanced students critical thinking abilities. Validation by subject matter and media experts showed an improvement in feasibility from "not feasible" to "feasible to use." Teacher assessments stated that the media is engaging and effective in promoting students' independent learning. The one-to-one trial resulted in a satisfaction score of 86.6%, while the small group trial obtained a score of 90.46%, both categorized as "excellent." Therefore, FunChem has been proven to be feasible for use and effective in improving students' understanding of concepts and critical thinking skills in colloid material.

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