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INTERACTIVE MULTIMEDIA BASED ON EDUCATIONAL MAZE GAMES FOR THE TOPIC: STRUCTURE AND NOMENCLATURE OF HYDROCARBON COMPOUNDS

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ABSTRACT

Hydrocarbon compounds are compounds consisting of carbon (C) and hydrogen (H) atoms. In this material, students are required to understand the structure and nomenclature of hydrocarbon compounds. Therefore, this material can also be made into an interesting learning tool if interactive multimedia based on educational maze games is used. Interactive educational multimedia games are one type of interactive educational media for training skills and teaching and learning activities for children. The purpose of this study is to determine the validity and practicality of learning media in the form of interactive multimedia based on educational maze games on the material of the structure and naming of hydrocarbon compounds. The type of research used is the DDR (Design and Development Research) method with the stages of analysis, design, development, and evaluation. The overall validity obtained from several subject matter, media, and language experts was 92%, categorized as highly valid. The practicality results from the teacher response test were 85%, categorized as highly practical, and the student response test results were 93%, categorized as highly practical. Therefore, this interactive multimedia learning media based on educational maze games is suitable for use and provides additional innovative and interesting learning media.

Keywords: Interactive Multimedia; Educational Game; Maze; Structure and Nomenclature of Hydrocarbon Compounds.

INTRODUCTION

One of the developments in the 21st century is in the field of technology (Lamada et al.,2021). With the rapid development of technology, it has had an impact on various aspects of life, one of which is education (Arif & Sumawati, 2016). Education for school children is currently a very important need. This is inseparable from the learning and teaching process (Lamada et al.,2021). Students today find it difficult to understand the material presented by teachers in a conventional manner. The material presented can be considered abstract or unrealistic (Susanto et al., 2013). As a result, students are less motivated to use their thinking skills and most students are only able to memorize information. One of these subjects is science (Qusyairi, 2017). The science subject that students find difficult to understand is chemistry (Manggabarani & Masri, 2016). This is based on journal observations conducted by Arham & Dwiningsih (2016), which stated that there were students who said they were not interested in learning chemistry, as shown by the research results that 22.86% of students said they were not interested, and 8.57% of students said the media was not interesting. It can be concluded that the learning was not interesting because the media was not interesting.

According to Arsyad (2011), media functions as an intermediary or channel in assisting the learning process and facilitating teaching and learning activities. Today's learning media are made as attractive as possible by combining educational and entertaining aspects (Agustina Elisa, 2021). Various learning media can be presented, including animations, picture comics, computer-based media (PowerPoint), audio-visuals, and interactive multimedia (Panjaitan et al., 2020).

Based on observations at Tambang High School 2, the learning media currently used by teachers include printed books, student worksheets, PowerPoint presentations, and educational videos. In addition, the school provides adequate facilities and infrastructure, such as LCD projectors, and the learning process also utilizes smartphones. Meanwhile, based on interviews with teachers, the learning process already uses the independent curriculum. The independent curriculum requires teachers to choose the appropriate learning media according to the needs of students. Meanwhile, students want learning media that incorporates elements of play. Learning media that can be combined with play, such as interactive multimedia, is desirable. However, teachers have never tried this type of learning media, so they are interested in trying interactive multimedia.

Interactive multimedia can be used as a learning medium that plays a role in improving student understanding and has a positive effect on improving student learning outcomes (Siswoyo et al., 2023). This interactive multimedia comes in various types, such as tutorial models, interactive multimedia based on learning styles, interactive multimedia accompanied by exercises, interactive multimedia based on Android, and interactive multimedia with educational games (Panjaitan et al., 2020).

Educational games are one type of game that has become an alternative learning medium today (Ira et al., 2020). Media containing games can facilitate the communication of learning materials that are easy for teachers and can also attract students' interest. Thus, games have advantages that can bring out the positive values that students enjoy and can make the learning atmosphere more enjoyable (Wulandari et al., 2017). One game that is popular and easy to play is the maze game (Sumitro & Zuhrie, 2019).

A maze is a complex branching structure with many dead ends. There have been many maze games available, but these games are only for entertainment purposes (Pamungkas et al., 2011). The objective of the game is for players to find their way out from one or more entrances to the exit. If players successfully reach a certain point in the maze, they are also considered to have won (Akhadiyah et al., 2025). The concept of maze games is not entirely new in the world of educational games, especially in the context of chemistry, particularly hydrocarbon material.

This hydrocarbon material offers strong novelty value for teaching hydrocarbon concepts, such as the classification of alkanes, alkenes, alkynes, isomers, and IUPAC nomenclature. This application is specific and has not been widely developed, thus providing novelty value in terms of the learning context. In addition, this material is fundamental for learning subsequent material, so students must master it correctly.

From the explanation above, it is necessary to innovate learning media in the form of Interactive Multimedia Based on Educational Maze Games for Hydrocarbon Compound Structure and Nomenclature Material. This is in accordance with the results of research by Subagio et al. (2015), which shows that wall maze games can attract students' interest in learning through play. Furthermore, the results of research by Angwarmasse & Wahyudi (2021) show that educational maze

games are suitable for use in learning, as evidenced by the results of students' problem solving. Furthermore, the results of research by Susanto et al. (2013) found that students learned well from interactive multimedia with educational games.

This study uses type 1 DDR method with the aim of designing and developing a product. In addition, it formulates the problem of how to design interactive multimedia based on educational games on the material of the structure and naming of hydrocarbon compounds and how the validity and practicality of learning media in the form of interactive multimedia based on educational maze games on the material of the structure and naming of hydrocarbon compounds. The results of this study are expected to answer these problems.

RESEARCH METHODS

The research method used is the Design and Development Research (DDR) method. This method has two types, namely "Product and Tool Research" (type 1) and "Research on Design and Development" (type 2). DDR type 1 is research that directly produces products with certain conditions, such as the development of teaching materials. Meanwhile, DDR type 2 is more oriented towards the analysis of a model, development, and learning process. This study uses the DDR type 1 method because it reflects an interest in identifying general development principles or specific recommendations for certain situations. In addition, this development method is usually used by several previous studies to create new products or develop existing products. The DDR type 1 model developed in this study is an interactive multimedia product based on an educational maze game. The development of the DDR research method consists of four stages, namely (1) the needs analysis stage (analysis); (2) the design stage (design); (3) the product development stage (development); and (4) the evaluation stage (evaluation) (Richey and Klein, 2014). The stages are as follows:

Analysis Stage

In this analysis stage, researchers gathered information about issues in learning activities and identified solutions to overcome these problems. This information was obtained through interviews with teachers and grade XI students at SMAN 2 Tambang.

Design Stage

In the design stage, the researcher plans the analysis found in the field according to the needs of the students. At this stage, the learning media in the form of interactive multimedia based on educational maze games will be designed, based on the analysis found in the field. After the design process, this media can be taken to the next stage.

Development Stage

The development stage is the stage of product realization, where what has been designed or developed is brought to life. Development steps include creating and modifying learning media. This stage also includes the product validation process, with the aim of obtaining assessments and suggestions and minimizing errors so that revisions can be made. There are several validations that must be carried out, namely validation by subject matter experts, media experts, and language experts. To obtain validity results, a Likert scale questionnaire instrument is used. After the validation stage and obtaining a score, if the score obtained meets the validity criteria, the media does not need to be revised, whereas if the score obtained is below the validity criteria, the media must be revised based on input and suggestions from the experts. After the media meets the validity criteria, the learning media will be tested on students in the next stage.

Evaluation Stage

The next stage is the evaluation stage. The evaluation stage is a trial stage for the developed product to assess its practicality and response. At this stage, a Likert scale questionnaire is also used to obtain practicality results from participating chemistry teachers (Hidayah & Permadi,2023). The following table shows the validity and practicality criteria:

Table 1. Validity Criteria

Validity Criteria	Validity Level
81,00 % - 100,00 %	Very valid, can be used without revision
60,00 % - 80,00 %	Valid, can be used with minor revisions
41,00 % - 60,00 %	Less valid, can be used with many revisions
21,00 % - 40,00 %	Not valid, cannot be used yet, still requires significant revisions
00,00 % - 20,00 %	Highly invalid, should not be used

Source: (Riduwan, 2007)

Table 2. Validity Criteria

Practicality Criteria	Practicality Level
80 % - 100 %	Very Practical
60 % - 79 %	Practical
40 % - 59 %	Fairly Practical
20 % - 39 %	Less Practical
0 % - 19 %	Not Practical

Source: (Dewi Fortuna et al., 2021)

RESULTS AND DISCUSSION

This study was conducted to determine the validity and practicality of interactive multimedia learning media based on educational maze games on the material of the structure and nomenclature of hydrocarbon compounds using the Design and Development Research (DDR) type 1 method, which includes the following:

Analysis Stage

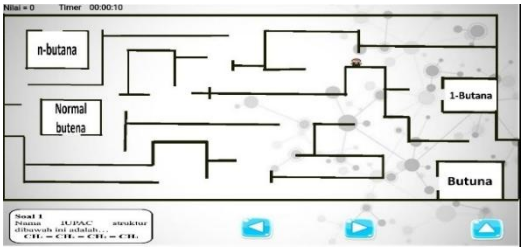
In this analysis stage, interviews were conducted with teachers and students to understand the field conditions, student characteristics, and to conduct needs analysis and material analysis based on the applicable independent curriculum. Product development needs analysis is important to ensure that the product to be developed meets the needs of users. The interview information was obtained by the researcher from teachers and students in grade XI at SMAN 2 Tambang.

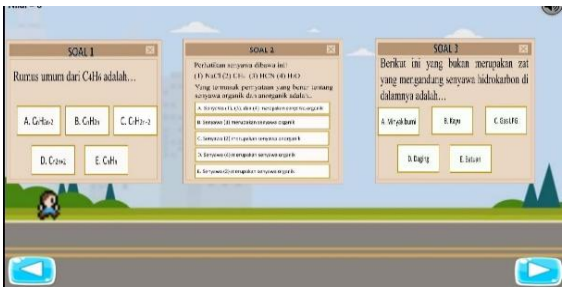
Based on the results of interviews with chemistry teachers at SMA 2 Tambang, it was found that chemistry learning already uses the independent curriculum. Thus, chemistry learning is directed at students, requiring them to be active and independent in learning. In addition, teachers are also required to choose media that suits the needs of students. In addition to books, teachers also use several media such as LKPD, learning videos, and materials displayed in PowerPoint. Some of the media that have been used need to be supplemented with the students' learning needs. However, due to the limited time available for teachers to create media, teachers are interested in trying learning media that contains games. In addition, the teacher also provided information that in class XI, which currently has 4 classes, the students' learning abilities are heterogeneous. Some students are quick to respond to the material presented by the teacher, while others are slow to respond. Students' responses to the learning provided by the teacher using media are very enthusiastic and they are interested in learning. This is also supported by the results of student interviews, which provide information about students' interest in learning using learning media. Students consider chemistry lessons to be more difficult to understand, unpleasant, and boring. Students are more interested in media that is combined with games to make learning more enjoyable. Another supporting factor is the use of smartphones by students.

Design Stage

At the design stage, the process of creating products needed by students is carried out. Based on the interview results, problems were found in the field. The results of the analysis stage from the interview were that teachers and students needed innovative and up-to-date learning media. Therefore, developers need to design the necessary innovative media. For product design, researchers need an initial framework or design called a storyboard. In addition, this stage also includes determining the validators from several experts needed by the researcher. Validators will assess whether the developed media is appropriate and suitable for use during the research (Nurfadhillah, 2021). The researcher used five validators consisting of two media experts, two media experts, and one language expert. The following are the results of the final product design of this learning media.

Table. 3 Product Design

Product Design	Description
	Cover Display
	Main Menu Display
	Introduction Material Display
	Menu Display
	Maze Game one Display
	Maze Game one Display



Evaluation Question Display

Game Score Display

Development Stage

This development stage is the process of turning the design into reality. In this stage, the media designed by the researchers is then created and developed. This media is developed using the Construct 2 application. Construct 2 is HTML 5-based game design software specialized in creating 2D game engines (Putri et al., 2023) . The developed media is then tested for validity by subject matter experts, media experts, and language experts. The validity test is conducted by distributing a questionnaire that has been validated by the research instrument validator.

Validity Test

The product validity test was conducted by experts. The aim was to obtain an assessment of the developed media and to receive input and suggestions for the developed media. The assessment by these experts involved 5 experts consisting of 2 subject matter experts, 2 media experts, and 1 language expert.

Table 4. Expert Material Validity Results

Aspect	Score (%)	Kategori
Subject Matter Relevance	98 %	Very Valid
Material Organization Aspect	94 %	Very Valid
Language Suitability Aspects	89 %	Very Valid
Evaluation Aspects	95 %	Very Valid
Visual Display Aspects	99 %	Very Valid
Learning Strategy Aspects	93 %	Very Valid
Total	**94.5 %**	**Very Valid**

Based on Table 4, the total score obtained for this learning media in terms of material is 94.5%, which is categorized as Very Valid. This media is considered highly valid in terms of material because it is supported by one aspect of relevance, which scored 98%. This aspect includes the material in this media being appropriate, the material presented in the media being in accordance with ATP and CP, the suitability of the flow with the learning objectives, and the accuracy of the concepts. This is in line with the research conducted by (Sulistyowati & Poedjiastoeti, 2013) that the relevance aspect contains components of synchronization and the correctness of concepts or scientific facts in the developed media. Thus, the validity of the subject matter experts can be concluded to be suitable for use as teaching materials in schools.

Table 5. Media Expert Validity Results

Aspect	Score (%)	Kategori
Media Suitability Assessment Aspect	82.3 %	Very Valid
Operational Aspects	85 %	Very Valid
Language Suitability Aspects	88 %	Very Valid
Effect on Learning Strategy Aspects	84 %	Very Valid
Total	**89 %**	**Very Valid**

Furthermore, the validity test of the media was seen in Table 5, which obtained a total score of 89% in the Very Valid category. This media is considered very valid in terms of media because it is supported by one aspect of the learning strategy that obtained a score of 84%. This aspect has a scope of benefits for learning, which can be seen from the fact that this media has not only material menus but also exercise questions in the form of games and evaluation questions in the form of games. This is intended to provide the benefits of the media to motivate learning, support and encourage student learning, and increase student understanding and knowledge. This is in line with the research conducted by (Aini et al., 2018) that the learning strategy aspect includes media support and increases student knowledge. Thus, the validity of the media expert can be concluded that the media is very suitable for use as teaching material in schools.

Table 6. Language Expert Validity Results

Aspect	Score (%)	Kategori
Direct Aspect	97 %	Very Valid
Communicative Aspect	100 %	Very Valid
Dialogic and Interactive Aspects	96 %	Very Valid
Student Suitability and Development Aspects	100 %	Very Valid
Aspects of Conformity with Language Rules	100 %	Very Valid
Appearance Aspect	100 %	Very Valid
Total	**93 %**	Very Valid

Furthermore, the validity of language experts can be seen in Table 6, which shows a total score of 93% in the Very Valid category. In terms of language, the media is considered valid because it is supported by a dialogical and interactive aspect that scored 96%. This aspect includes the ability to motivate students and encourage them to think. The ability to motivate students is seen from the pleasure they feel when reading. Meanwhile, the ability to encourage critical thinking is seen from sentences that contain curiosity and sentences that encourage students to take action. According to Rahmawati et al. (2016), the dialogic and interactive aspects are related to the interaction and communication between the learning media and students. This can be seen from the language used, which contains question, command, and invitation sentence structures. Therefore, the linguistic validity can be concluded to be very suitable for use as teaching material in schools.

Table 7. Overall Validity Results

No	Validity Variable	Persentase	Kategori
1	Subject Matter Experts	94.5%	Very Valid
2	Learning Media Expert	89%	Very Valid
3	Language Experts	93%	Very Valid
	Total	**92%**	**Very Valid**

Based on Table 7, the overall percentage results of the assessment by learning media experts, learning material experts, and language experts. The validity test results show that the interactive multimedia-based educational maze game is in the highly valid category with a score of 92%, which indicates that the media has met the eligibility criteria in terms of material, media, and language. In terms of content, media, and language validity, the media has been assessed as providing benefits to educators in delivering content effectively and efficiently, and can assist the learning process by making learning objectives more interesting and easier for students to understand. This can be seen through the presentation of material in the form of animations, educational games, and interactive quizzes, which encourage students to be more active in exploring information and understanding the lesson material in depth through the available content. However the limitation of the research is that

it only covers the development stage, thus indicating that validity reflects the feasibility of the media design rather than guaranteeing learning effectiveness. Therefore, even though the media is declared to be highly valid, further testing is needed to assess the impact of the media on students' conceptual understanding, reasoning, and learning outcomes in greater depth. This is because the high validity of the media indicates the feasibility of the design, but does not guarantee learning effectiveness because, according to Mayer (2020) and Sweller et al. (2011), effective multimedia must be able to optimize students' cognitive processing, not just be visually appealing. Furthermore, this research should be continued to the next stage, which is the practicality test evaluation stage for chemistry teachers and students.

Evaluation Stage

The evaluation stage is a practicality test conducted to determine teachers' responses to interactive multimedia learning media based on educational maze games and a response test conducted to determine students' responses to the things they have learned after using interactive multimedia learning media based on educational maze games.

Practicality Test

The practicality test was conducted by chemistry teachers of class XI IPA and students of class XI at SMAN 02 TAMBANG. The results of the practicality test by chemistry teachers can be seen in Table 8 below.

Table 8. Practicality Results for Chemistry Teachers

Aspect	Score (%)	Kategori
Media Presentation Aspect	85.4 %	Very Practical
Presentation of Content Aspect	84 %	Very Practical
Learning Implementation Aspects	90 %	Very Practical
Readability Aspect	80 %	Very Practical
Time Aspect	80 %	Very Practical
Evaluation Aspect	88 %	Very Practical
Total	**85 %**	**Very Practical**

Based on the graph above, the results show a percentage of 85% in the very practical category and are suitable for use as teaching materials in schools. In terms of the practicality of learning media, there are several aspects that need to be considered to support the media. First is the media in terms of available formats, time used, and costs incurred. Second is the suitability for students, namely the suitability of the media content to the development and experience of students. Third is the suitability for educators, namely the suitability of the media for the learning conducted by educators and its ability to facilitate students in understanding the material through the media. According to Milala et al., (2021) Media is said to be practical with the category of learning media conditions that are developed to be easy to use by users, both students and teachers, so that the learning conducted is meaningful, interesting, enjoyable, and useful for students, as well as increasing creativity in learning. Furthermore, the practicality test of the students' responses to the presentation results can be seen in the following table.

Table 9. Practicality Results of Student Responses

Statement	Peresentase	Kategori
Interactive learning media display	91 %	Very Pratical
Attractive learning media display	95%	Very Pratical
The videos and animations in this interactive learning media are interesting	91 %	Very Pratical
The videos and animations in the learning media are very clear	91 %	Very Pratical
This interactive learning media makes me more enthusiastic about learning	96 %	Very Pratical
Interactive learning media is easy to use	80 %	Very Pratical
The instructions for using this media are very clear	95%	Very Pratical
The material presented in the interactive learning media is clear	92%	Very Pratical
The material presented in interactive learning media is easy to understand	93%	Very Pratical
The images, videos, and animations in the learning media help me understand the material.	95%	Very Pratical

The sample questions in this media help me understand the material	92%	Very Pratical
Communicative	89%	Very Pratical
Creative and innovative	94%	Very Pratical
Color selection	95%	Very Pratical
Image selection	94%	Very Pratical
Clarity of instructions for use of media	94%	Very Pratical
The language used in this media is easy to understand	97%	Very Pratical
Total	**93%**	**Very Pratical**

Based on the graph above, a percentage of 93% was obtained with the criteria of very practical. These practical results were tested on students from four classes, namely XI.1 – XI.4. Sampling was carried out using purposive sampling techniques. Purposive sampling techniques involve taking samples based on certain criteria. The researcher selected specific criteria in obtaining the results of learning evaluation in media that produced good results. From the 4 classes, 20 comments and suggestions were collected. One of the students stated that this learning media was very comprehensive and good for learning, easy to understand, interesting and creative, and enjoyable. The inclusion of games made learning less boring. These games attracted students' attention and motivated them to learn.

The results of the study show that interactive multimedia based on educational maze games has a very practical level of practicality, with 85% of chemistry teachers and 93% of students achieving positive results. These findings indicate that the media is easy to use, the interface is clear, and the game flow can be understood without significant technical obstacles. In terms of implementation, the media is considered to assist teachers in delivering material and facilitating active student engagement during the learning process.

However, the high practicality needs to be analyzed more critically. Practicality in this study was largely measured through user perception questionnaires, thus reflecting the level of user comfort and enjoyment rather than objective pedagogical efficiency. In the context of learning design theory, practicality is a minimum requirement for media to be used, but it is not the main indicator of learning success (Reigeluth, 1999).

In addition, the use of maze games has the potential to cause a novelty effect, whereby students assess the media as practical and interesting because of unfamiliar game elements, rather than because of its contribution to conceptual understanding. This condition can cause practicality to appear high in the early stages of use, but it may not necessarily last in the long term or in different learning contexts.

From the perspective of multimedia effectiveness, the practicality of the media also needs to be linked to the cognitive load of students. Although the media is easy to operate, game elements such as maze navigation time challenges, and decorative visuals can distract students from the main learning objectives. If not properly controlled, ease of use has the potential to increase extraneous cognitive load, thereby reducing the depth of concept processing (Sweller et al., 2011). Thus, the practicality of the media in this study shows that interactive multimedia based on maze games is feasible and easy to apply in the classroom, but further study is needed to ensure that its ease of use truly supports learning effectiveness and does not merely provide an enjoyable learning experience.

This is in line with previous research, which shows that educational games in the form of mazes can be very well designed and practical, which can aid in the learning process. It is hoped that learning through educational maze games will create an independent, active, enjoyable, interesting, and relaxed learning environment while still providing optimal results in achieving learning objectives. The use of games as a learning medium can also increase students' interest and motivation in the learning process (Sumitro & Zuhrie, 2019).

CONCLUSION

This interactive multimedia learning media based on educational maze games on the subject of hydrocarbon compound nomenclature and structure is used in 11th grade chemistry classes. This learning media can be accessed through each student's smartphone. The availability of smartphones among students can have a positive impact on the use of smartphones in learning. Designing interactive multimedia educational game-based media using the Construct 2 application software with the help of PowerPoint has produced very satisfying and useful results and responses for

teachers and students. The interactive multimedia educational maze game is recommended for use as a learning support medium, particularly in the concept introduction and basic practice stages of hydrocarbon compound nomenclature and structure material, as it has been proven to be valid and practical according to expert and user evaluations. The validity level of interactive multimedia learning media based on educational maze games on the subject of the structure and nomenclature of hydrocarbon compounds was declared highly valid, with a percentage score of 92%. The practicality level of interactive multimedia learning media based on educational maze games for hydrocarbon compound structure and nomenclature material obtained a percentage of 85% with a very practical category from chemistry teachers as practicality test experts. Student responses to interactive multimedia learning media based on educational maze games for hydrocarbon compound structure and nomenclature material obtained a percentage of 93% with a very practical category. Thus, it can be concluded that this product is suitable for use in the learning process. However, teachers are advised to integrate the maze game media with other learning strategies, such as conceptual discussions, molecular structure modeling exercises, or case-based problem solving, so that students are not only skilled at completing the game, but also have a deep understanding of chemical concepts. Further research is recommended using experimental or quasi-experimental designs, involving control groups and longer usage durations, to test the effectiveness of the media in improving student learning outcomes and conceptual understanding.

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