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Development of Matching Card Media as an Evaluation Tool on Mole Concept Subject

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Abstract

This study aims to measure the feasibility level and students' responses to the matching card media that was developed. This type of research is Research and Development with the 4D development model. Data collection techniques in this study used measurement techniques in the form of feasibility tests and student response questionnaires using a likert scale. The subjects of this study were the matching card media, with trial subjects being XI MIPA 1 students at SMA Negeri 5 Pontianak. Feasibility testing used the Gregory test conducted by two media experts and two graphic design experts. The feasibility test on the developed media met very high criteria with an average score of 1.00 in the material aspect and 1.00 in the graphics aspect. Students' responses to the media in the limited and main field tests were 95.58% and 92.55%, respectively, with very good criteria. Based on the results obtained, it can be concluded that the matching card media as an evaluation tool for the mol concept material is very feasible and received a very positive response. This study contributes to the development of interactive evaluation media for the mole concept material, which can enhance students' understanding, engagement, and motivation.

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INTRODUCTION

Media is essential for improving student learning outcomes. It accelerates the learning process and helps present information in ways that increase student interest and engagement (Nuryanto et al., 2015; Arsyad, 2017). Effective teaching should help students fully understand the material. However, many students struggle, particularly with calculations. Yakina et al. (2017) found that students often lack a strong foundation in mathematics and have a limited understanding of chemical calculation formulas. As a result, they tend to memorize formulas without applying them, leading to confusion when solving problems.

Preliminary research results indicate that chemistry materials involving calculations are considered difficult for students to understand. Among the XI MIPA 1 students at SMA Negeri 5 Pontianak, 69.4% experienced difficulties applying the mole concept in chemical calculations. This may be due to students' lack of understanding of chemistry concepts or insufficient deep comprehension of the material (Febriani et al., 2018; Aswita et al., 2017). Students tend to struggle with solving chemical calculations because they have difficulty determining which formulas to use. The above statement is in accordance with the interview findings, which revealed that students encounter difficulties in learning chemistry topics involving numerical calculations. This is indicated by student learning outcomes, which are still below the school's Minimum Competency Criteria (KKM).

In the 10th grade of senior high school (SMA) or Islamic senior high school (MA), the concept of the mole is one of the chemistry topics studied and is considered difficult by students. This

material discusses the concept of the mole, which is used to calculate the number of particles, mass, and volume of substances. This aligns with the characteristics of chemistry, namely (1) most chemistry material is abstract, (2) chemistry material is sequential and develops rapidly, (3) there is a vast amount of chemistry material to study (Middlecamp & Kean, 1985). In addition, students often experience confusion and misconceptions in calculating moles and have difficulty understanding the relationship between mass, volume, and the number of particles in stoichiometry. Therefore, a teacher's presence of is essential for helping students understand concepts effectively (Suryani et al., 2015).

Table 1. Average scores of the mole concept material

Academic Year	Minimum Competency Criteria	Completed (%)	Not Completed (%)	Average Score
2020-2021	76	30,5	69,4	53,47

Based on the explanation above, it shows that the conventional learning approach is less effective in building a deep conceptual understanding. Therefore, there is need for a way to make students more interested and make the concept of moles easier to understand. Arsyad (2017) states that learning using media can attract students' interest in learning, encourage students to take action, be motivated in learning, and even have a psychological impact on them. This is supported by data showing that 91.7% of 36 students need other interactive learning media.

Learning media support teachers in evaluating student progress. Effective evaluation provides students with feedback on their achievement of learning objectives and motivates them to enhance their skills. Learning assessments are often limited to worksheets completed individually by students and supervised by the teacher. This can lead students to feel bored with the learning process. Providing engaging evaluation tools is one way to make the learning environment enjoyable (Yanti & Susanti, 2017). Learning media in the form of matching cards can be an effective solution due to their interactive nature and their combination of visual, auditory, and kinesthetic aspect (Arnas et al., 2025). By using matching cards, students learn through the game of matching question cards with the corresponding answer cards, making the learning process more engaging and enjoyable. This method also encourages group discussions and collaboration, which help students better internalize the concept of moles through practical activities.

Matching cards are an effective learning tool that promotes student engagement and understanding. This is supported by research by Mardiansyah et al. (2014) which found that card matching improved students outcomes at SMAN 9 Pontianak by 27.07% and Irawati et al. (2024) found that the use of interactive card-assisted media with the make a match model could significantly improve chemistry concept understanding by 60%. Selfanay et al. (2022) also reported that 86% of students met the Minimum Competency Criteria using this cooperative learning strategy. Matching cards are a type of media in the form of a game that makes the classroom more active and less stressful. They are also practical, easy to use, and convenient to store due to their compact size (Khairunnisak, 2015).

Based on these findings, matching cards were developed as an evaluation tool for teaching the mole concept. This development is expected to become an alternative media in the learning process because it can encourage students to participate more actively in class and teach students to work together, thus making students more motivated during the learning process. This developmental research aims to determine the feasibility of matching card media for the mole concept material and students' responses to the media.

METHOD

This research applies the Research and Development method using the 4D model (Thiagarajan, 1974). which includes the stages of definition, design, development, and dissemination. However, due to time constraints, this research did not reach the dissemination stage.

The definition stage identifies learning needs through five steps: front-end analysis, which is conducted to identify teacher needs and problems that arise during the chemistry learning process; student analysis, which examines the characteristics of students in order to ensure the suitability between the teaching materials to be developed and the students' needs, abilities, and learning styles; task analysis, which is done to determine the material to be used in the media to be developed; concept analysis, which aims to identify concepts in developing learning media while taking into account relevant considerations; and the formulation of learning objectives based on basic competencies serves as the foundation for developing the learning media.

The design stage focuses on developing matching card media. The steps carried out in this stage include selecting the media, which is done to identify learning media that are relevant to the characteristics of the material and suitable for the needs of the students; choosing the format is intended by designing the media to be developed by reviewing existing device formats and creating an initial draft of the product to be developed before testing.

The development stage is the final form of the media being developed. At this stage, the product will be created and its feasibility assessed by experts, followed by trials conducted by students. Feasibility testing assesses the suitability of the media and gathers feedback for design improvements. The trial activity is carried out in two stages: limited trial and main trial. The limited trial is conducted on the target subjects, which is a small group of eight students of XI MIPA at SMA Negeri 5 Pontianak, while the main trial involves a larger group of 26 students of XI MIPA 1 at SMA Negeri 5 Pontianak to assess student responses and evaluate the quality of the developed product. Based on the product trial, if the responses from teachers and students meet the criteria for use in learning, the researcher has obtained the final product results. However, if it does not meet the criteria, further improvements are needed, so that the matching card is feasible for use in classroom learning.

This study focused on matching card media for teaching the concept of moles, with trials conducted by 11th-grade science students from class XI MIPA 1 at SMA Negeri 5 Pontianak. Data were collected through feasibility tests, interviews, and response questionnaires. The data were analysed using a likert scale and include both feasibility test results and student feedback on the media.

Feasibility testing was conducted using Gregory's test by four experts, consisting of one high school Chemistry teacher and three Chemistry lecturers as content experts and graphic experts. Data processing used a likert scale as follows: very good with a score of 5, good with a score of 4, adequate with a score of 3, less with a score of 2, and very less with a score of 1. The research results were compiled into a Gregory index comparing the number of items from both experts with categorization ranging from not relevant (score 1 – 2) to relevant (score 3 – 5). The formula for calculating media feasibility used is as follows.

$$\text{Content Validity} = \frac{D}{A+B+C+D} \text{ (Larasati \& Syamsurizal, 2022)}$$

Explanation:
A = Experts 1 and 2 state it is not relevant
B = Expert 1 states it is not relevant and Expert 2 states it is relevant
C = Expert 1 states it is relevant and Expert 2 states it is not relevant
D = Experts 1 and 2 state it is not relevant (Gregory, 2004).

The interpretation of Gregory's test results is as follows.

Table 2. Content Validity Criteria

Value Interval	Criteria
0.80 – 1.00	Very High
0.60 – 0.79	High
0.40 – 0.59	Moderate
0.20 – 0.39	Low
0.00 – 0.19	Very Low

(Br Tarigan et al., 2021)

The analysis of the interview results is to describe and draw conclusions based on data from structured interviews conducted with teachers. To understand students' responses to the developed product, a questionnaire was used as a tool to collect data consisting of positive and negative statements.

Table 3. Criteria for Processing Likert Scale Data of Student Responses

Positive Statement		Negative Statement	
Answer Option	**Score**	**Answer Option**	**Score**
Strongly Agree	5	Strongly Disagree	1
Agree	4	Disagree	2
Somewhat Agree	3	Somewhat Agree	3
Disagree	2	Agree	4
Strongly Disagree	1	Strongly Agree	5

Then the obtained data will be calculated to determine the criteria using the following formula.

$$P = \frac{\sum X}{\sum Xi} \times 100\% \text{ (Riduwan, 2016)}$$

Explanation:
P = Percentage of score obtained
$\sum X$ = Total score obtained for each item
$\sum Xi$ = Sum of ideal scores (highest scores)

Then the average percentage of the total responses is calculated using the formula:

$$V = \frac{\sum P}{n} \text{ (Riduwan, 2016)}$$

Explanation:
V = Average feasibility percentage
$\sum P$ = Sum of the average percentage scores of each aspect
N = Number of aspects evaluated

The determination of research interpretation criteria based on calculation results can use the following criteria:

Table 4. Student Response Interpretation Criteria

Value Interval (%)	Criteria
0 - 20	Very Poor
21 - 40	Poor
41 - 60	Fairly Good
61 - 80	Good
81 - 100	Very Good

(Riduwan, 2016)

RESULTS AND DISCUSSION

This study utilized the Research and Development (R&D) approach, resulting in a product in the form of matching card media designed for the mole concept topic. The research adopted the 4D development model, which consists of the define, design, develop, and disseminate stages. However, only the define, design, and develop stages were implemented in this study. The purpose of the developed product was to assess its feasibility and gather students' responses toward the media.

The first stage is defining; the analysis was conducted through interviews with chemistry teachers at SMA Negeri 5 Pontianak and by distributing questionnaires via Google Forms to 34 students of class XI MIPA 1. Results indicated that students struggle with calculation-based chemistry topics, such as the mole concept in stoichiometry. The daily test results have not met the Minimum Competency Criteria (KKM), indicating that students' learning outcomes in the mole concept material are low. The teaching media used by the teachers are printed books or Student Worksheets (LKS) using a problem-solving learning strategy. Nevertheless, students feel unmotivated in learning. According to Piaget's theory, ndividuals in the formal operational stage, from age 11 through adulthood, can think logically, draw conclusions from information, and use systematic thinking to consider multiple solutions to problems. (Nursalim et al., 2017). However, in reality, students still require concrete evidence to understand the lesson material (Fadilla, 2021). After analyzing students' learning outcomes on the mole concept material, the results were low or below the minimum completeness criteria (KKM). One strategy to address this problem is by developing learning media that is more engaging and not monotonous. Students can play while learning using a game-based media in the form of matching cards containing questions on the mole concept material. Through this media, students are able to solve chemistry calculations by analyzing the mole concept.

The second stage is design, which involves creating an initial plan for the matching card media to be developed. Developing test standards and selecting media are very helpful to ensure that the media created meets the needs of the students. Test standards are prepared using student analysis and defined learning objectives. In this study, matching card were developed as an evaluation tool. Next, the matching card media is designed based on the mol concept material according to the storyboard. The designed matching card media consists of three types of cards, namely question cards, answer cards, and instruction cards. One set of matching cards contains 14 question cards, 20 answer cards, and one instruction card. The matching cards are made from cartoon art with dimensions of 6 cm x 8.5 cm. The selection of this card size is supported by the opinion of Tjakra et al. (2013), who stated that game cards are a collection of hand-sized cards used in games. This size was carefully chosen to ensure student comfort when using it (Septaria et al., 2022).

In designing the matching card media, supporting software such as Canva and Adobe Photoshop is used. The format of the matching card consists of several parts: (1) card box, containing the identity of the matching card, (2) question card, containing the front cover and the question on the back of the card, (3) answer card, containing the front cover and the answer on the back of the card, (4) instruction card, containing the front cover and usage instructions on the back of the card. Next, an initial draft of the media to be developed is created before being tested on experts and students. These cards will be presented in the form of an interactive learning game that will attract attention and be easily understood by students (Dony et al., 2019). Learning media in the form of games allows for greater sensory engagement as it provides hands-on experiences to students involving visual, auditory, and kinesthetic senses (Salam et al., 2019).

The final stage in this research is the development stage. This study aims to determine the level of validation of the matching card media on the mol concept materials that were developed.

Therefore, the development in this study was carried out through feasibility tests and student response tests. Feasibility was reviewed from the aspects of material and graphics by two experts for each aspect. At this stage, the experts also provided opinions and suggestions to be used in improving the developed matching card media (Novayanti, 2017). The results of the validation can be seen in Table 4.

Table 4 Expert Assessment

Aspect	Average	Criteria
Material	1.00	Very High
Graphic	1.00	Very High
Average	**1.00**	Very High

The research results show that the developed matching card media received an average score of 1.00 with a very high criterion, so it can be concluded that the developed matching card media meets the criteria of very high validity and is suitable for application in chemistry learning. Based on the feasibility test of the matching card media in terms of content, it is known that the presented questions are in accordance with the Basic Competencies and Competency Achievement Indicators, and are accompanied by appropriate answers. The questions presented cover the material being taught and can help students understand the material well. Furthermore, the language used in the matching card media is clear, easily understood, and suitable for students' cognitive levels, adhering to the Enhanced Spelling System (EYD) (Handayani et al., 2024).

Based on the feasibility test results of the matching card media in terms of graphics, it received a very high validity criterion. Matching card media is easy to store, manage, and use. Matching card can be reused with good durability using improved paper materials. Matching card media can be reused at another time (Setyorini et al., 2023). Arsyad (2017) states that one principle in selecting learning media is that the media should be flexible, practical, and durable. The instructions for using the matching card media are clear, but there are still improvements to be made (Table 7). The colors and design of the matching cards are harmonious and attractive to use, making it easier for users to utilize the matching cards. The language used in the matching cards does not contain any offensive elements and is communicative, so students do not feel confused when using them. There are several improvements and suggestions from graphic design experts for the developed product. The improvements were made according to unmet needs. The results of the improvements can be seen as follows.

Table 5 Cover Revision

Suggestion	Before Revision	After Revision
On the cover of the question card and instruction card, it is necessary to add information like on the answer card.		

On the cover of the question card and instruction card, experts suggest adding a label similar to that on the answer card, namely 'Answer Card'. The suggested additions are 'Question Card' and 'Guidance Card', which can be seen in Table 5. On the instruction card, experts recommend adding information about the content and number of cards. This is intended so that card users can know what is included in the matching card. The improvements can be seen in Table 6.

Table 6 Instruction Card Revision

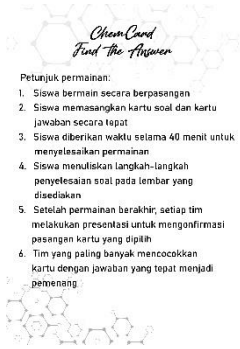
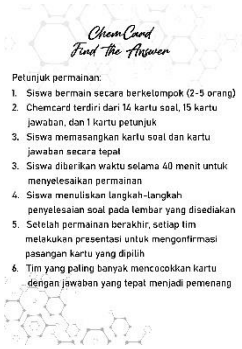
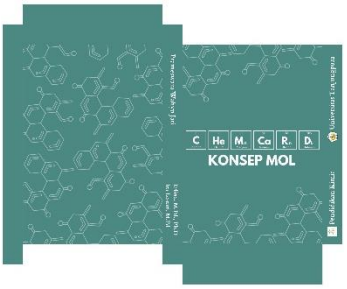
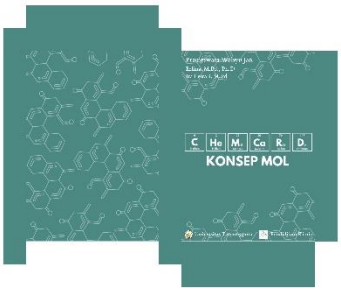
Suggestion	Before Revision	After Revision
The instruction card needs to include information about the contents or the number of cards.		

Table 7 Matching Card Box Revision

Suggestion	Before Revision	After Revision
On the card box, the researcher's name and institution are placed on the front of the box.		

On the matching card box, experts suggest that the researcher's name and institution should be placed on the front of the box. This is done so that users can more easily recognize the identity of the creator of the matching cards, as shown in Table 7.

Table 8 Question and Answer Card Revision

Suggestion	Before Revision	After Revision
The text on the question cards is enlarged, numbered, and given letters on the answer cards.		

On the question cards and answer cards, experts suggested enlarging the text on the question cards, numbering them, and labeling the answer cards with letters. This is intended to make it easier for users to match them and for teachers to correct the matching cards. The improvements can be seen in Table 8.

After making improvements based on expert suggestions, the matching card media can proceed to the next stage, which is the trial. The trial is conducted to determine how students respond to the matching card media using a response questionnaire. The questionnaire is used after conducting learning with the matching card media. The trial is carried out in two stages: the limited trial and the main trial (Karmia et al., 2023).

A limited trial was conducted on eight students of X MIPA 1 at SMA Negeri 5 Pontianak, who were selected randomly. The limited trial was carried out to observe the students' initial responses to the matching card media. The main trial was conducted after making improvements based on the suggestions given during the limited trial. The main trial involved 26 students of XI MIPA 1 at SMA Negeri 5 Pontianak. The percentage results of the responses from the limited and main trials on the matching card media are shown in Figure 1.

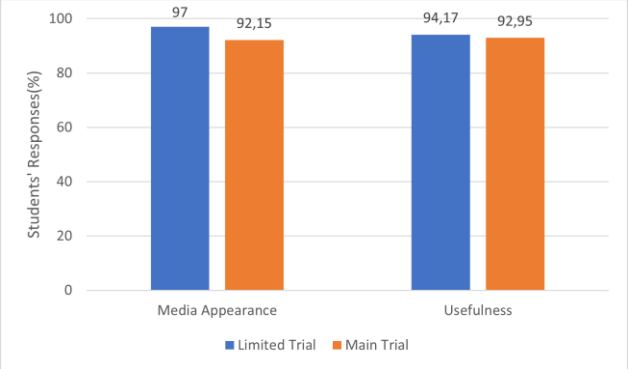


Figure 1. Percentage of trial test results (N=34)

Figure 1 shows that the media appearance in the limited trial obtained a percentage of 97% with a very good criterion, while the main trial results obtained a percentage of 92.15%, also with a very good criterion. The highest percentage in the media appearance aspect indicates that the matching card is appealing to use. This is supported by the size and design of the matching card, including the choice of colors, font size, font type, and spacing, which effectively facilitate users when playing it. The instructions on the matching card also help users understand the rules and resolve issues during the game. Having media usage instructions makes the media easier to use (Ananda, 2017). However, in the limited trial, there was a suggestion from students that the decimal numbers on the answer cards should not be rounded to minimize errors. And in the main test, there was one student response stating that the size of the matching cards was not appropriate. However, this does not necessitate changing the size of the matching cards, as 25 other responses indicated that the size of the matching cards was already appropriate.

Feedback provided by students and experts indicates that several adjustments need to be made to improve the quality of the media, particularly in terms of graphics and content. These adjustments emphasize that the quality of learning media is determined not only by its visual appearance but also by pedagogical accuracy and the clarity of the material presented. With the recommended improvements, the matching card media has the potential to become a more effective, engaging learning aid that responds to students' needs in understanding chemistry concepts in depth. This aligns with Arsyad (2017), who states that effective learning media must meet visual aesthetic standards while also adhering to instructional principles to ensure that information can be optimally received by students.

In terms of usefulness, students reported feeling more motivated and found it easier to comprehend the mole concept when using the matching card media. According to Hoerunnisa et al. (2019), student learning outcomes can be influenced by motivation, which serves as a key factor in the teaching and learning process. Learning with matching cards encourages students to be actively engaged and increases their curiosity. Students also perceive benefits and enjoy using them. Students who use matching cards are more interested, motivated, and able to fully participate in the learning process (Mardiansyah et al., 2014). Students' interest in the media used will make them feel happy and encourage them to participate more actively in learning (Hutagalung et al., 2020), and their attention will be focused on learning and they will not become easily bored (Nugraha et al., 2013). According to Andriani (2019), the implementation

of card match with an active learning strategy makes students more responsible toward their groups. Students will pay serious attention to the material to prepare themselves to complete questions and match the cards. This learning helps students understand the material because they can share opinions and ask their groupmates about things they do not yet understand (Sayuga, 2014). According to the students, learning using matching card media is enjoyable. Successful teaching and learning in the classroom requires active participation not only from the teacher but also from the students(Nurrita, 2018). Setyorini et al. (2023) stated in their research that paired-card multimedia has an effect on increasing students' motivation to explore understanding of the material, making it easier for teachers to engage students. The limited trial had a usefulness aspect percentage of 94.17% with a very good criterion, while the main trial had a percentage of 92.95% with a very good criterion.

In the main trial, there was a decrease in the percentage of student responses. However, this decrease was not found to be critical. This may occur due to several factors, including the cognitive level of the students and their characteristics. Factors affecting cognitive development include environmental factors, heredity/genetic factors, interests and talents, formative factors, maturity factors, and freedom factors (Sujiono, 2009).

The average student results on the response test indicate that the matching card performed very well. This shows that many students are interested in using matching cards in learning. This aligns with Mulyani (2017), who found that card media can improve learning outcomes by 33.3%. The use of matching card media as an evaluation tool is also quite effective to implement in the classroom because the execution time is predetermined, and once the allotted time is up, students cannot proceed to complete the next questions.

Based on the responses from students and observations during the trial process, the matching card media is able to provide a more interactive learning experience, encouraging students to actively participate in the learning process. Students also feel more enthusiastic and motivated with the presence of this media. This is proven by one student's feedback, who said, “With the use of matching cards, I become more enthusiastic about learning the concept of moles. The learning is unique and enjoyable”.

Students use matching cards by first analyzing the questions, then determining the answers based on their understanding, and matching the cards with their pairs. Students gain knowledge to complete questions related to the material and can master the material. Through practicing questions, it can influence the improvement of students' learning outcomes (Aspini, 2020). Learning in small groups can also stimulate students to be more enthusiastic about studying and collaborating (Isjoni, 2011). Students experience difficulties when working on questions because they are not familiar with the question format, which makes it challenging for them to understand and solve them. In addition, students may have difficulty solving questions because they do not remember formulas and do not pay close attention (Saraswati, 2020).

During learning using matching cards, students are more active, enthusiastic, and motivated. Implementing matching cards as a game-based learning leads to a high response from students. This aligns with the statement by Sadiman et al. (2011) that games are enjoyable and entertaining activities. Therefore, matching cards can be considered valid as a learning media because they are effective in helping achieve learning objectives (Afifurrahman, 2015). In addition, competitive and collaborative games can increase students' motivation to learn, as they feel both challenged and entertained during the learning process. This contributes to a reduction in boredom that often occurred when students had to study chemistry material through monotonous lecture methods or practice exercises.

The matching card media differs from the conventional learning methods commonly used by teachers, making matching card media a learning tool preferred by students. Rosyid et al.

(2019) stated that the goal of using of learning media in schools is to provide different and diverse learning experiences to increase students' interest and motivation towards the lesson material. This is in line with Ramli (2012), who stated that the function of media is to help students accelerate their understanding, assist educators in their tasks, and enhance the teaching and learning process. Additionally, learning becomes more varied because students participate in its use (Fatmawati, 2019).

CONCLUSION

Based on the results obtained from the research and development that has been conducted, it can be concluded that the matching card media for the mole concept material is suitable to be applied in chemistry learning. This is demonstrated by the eligibility test results on the aspects of material and graphics, each scoring 1.00 with very high criteria. Furthermore, a very good response was obtained from the students, as shown by the response results of 95.58% in the limited trial and 92.55% in the main trial, with very good criteria. The novelty of this research lies in the development of interactive evaluation media, which has not been widely applied before, thus capable of enhancing students' understanding, engagement, and motivation. The impact of this research is evident in the availability of more attractive and practical evaluation tools for teachers, while also providing a more interactive learning experience for students. However, further research is needed to test the effectiveness of this media in real learning situations, particularly through classroom implementation that compares learning outcomes before and after using the media.

RECOMMENDATIONS

The media matching card can be used as one of the alternative learning media that is engaging and interactive for teachers when conducting evaluations on the mol concept material. The development of this media is recommended not only to be limited to the mol concept material but also can be expanded to other chemistry materials so that its use is more varied and applicable. In addition, the design and appearance of the matching card need continuous improvement, both in terms of visuals and content, making it more appealing and aligned with the characteristics and needs of students. Future researchers are also expected to develop the matching card media into digital-based games or online games to make it more engaging, interactive, and easily accessible to students. Furthermore, further research is needed to test the effectiveness of using matching card media on improving learning outcomes and student engagement in the classroom learning process.

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