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Development of Truth or Dare Card-Based Learning Media for Teaching Reaction Rates in Senior High School

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Abstract
This study aimed to develop a Truth or Dare card-based learning medium for the topic of reaction rates and to evaluate its validity and practicality. A research and development design was employed using a modified 4D model limited to the Define, Design, and Develop stages. The field trial involved 36 eleventh-grade students from Class XI A at SMAN 2 Sungai Raya, comprising 9 students in a small-group trial and 27 students in a large-group trial. Data were collected through observation, interviews, documentation, expert validation sheets, and student response questionnaires. The product was evaluated by material and media experts, while its practicality was assessed based on students' responses. The results showed that the developed medium obtained an average validity score of 96.66%, indicating a very high level of validity. The practicality score reached 86.67% in the small-group trial and 89.26% in the large-group trial, both of which were classified as very practical. These findings demonstrate that the Truth or Dare card-based medium is valid and practical for supporting the teaching of reaction-rate concepts in senior high school. However, its effectiveness in improving students' conceptual understanding and learning outcomes requires further empirical testing.

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Introduction

Education plays a strategic role in developing high-quality human resources capable of competing in the global era. Through education, students are not only required to master knowledge but are also expected to develop holistically in the cognitive, affective, and psychomotor domains (Lyna Luthfiyyah Azzahra & Roro Ayu Angeli, 2025). To achieve this development, the learning process needs to be designed to be active, interactive, and enjoyable so that it can optimize the potential of students (Nurtanto & Sofyan, 2015). This condition becomes increasingly important in science subjects, including chemistry, which require deep conceptual understanding and high-level thinking skills.

Chemistry is a subject characterized by abstract and complex material, requiring learning strategies that can help students understand concepts concretely. Although chemistry can develop critical and analytical thinking skills, many students struggle to connect chemical concepts to real-world phenomena (Ananda Aditya Sari Harahap et al., 2023). One topic that often presents obstacles is Reaction Rate, as it involves abstract concepts and quite complex mathematical calculations. This complexity often leads to misconceptions and results in poor learning outcomes (Putri & Muhtadi, 2018). Therefore, learning innovations are needed that can facilitate understanding more effectively.

Based on direct observations at Sungai Raya 2 State Senior High School, it was discovered that the chemistry learning process is still dominated by lectures. During the learning process, students

appear passive and tend to simply listen and take notes, without adequate opportunities for discussion or interactive learning activities. This situation makes learning less engaging and does not optimize in-depth conceptual understanding.

These observational findings were reinforced by interviews with chemistry teachers at SMAN 2 Sungai Raya. The teachers reported that the Reaction Rate material was difficult for students to understand because it involved abstract concepts and mathematical calculations. They also stated that the limited variety of learning media resulted in monotonous delivery, making students easily bored. Interviews with several grade XI A students revealed similar findings, stating that the learning process felt less engaging because it focused solely on teacher explanations and practice problems from textbooks. Furthermore, they also reported difficulty understanding the Reaction Rate material because it included many formulas and theories. The lack of varied learning media also reduced learning motivation and hindered optimal conceptual understanding (Aulia et al., 2018). To address these issues, innovative, engaging learning media are needed that encourage active student involvement in the learning process.

One alternative media that can be used in learning is Truth or Dare cards, specifically designed for reaction rate material. This media integrates game elements with learning activities through a game-based learning approach, so that students are actively involved in the learning process. Truth cards contain conceptual questions that encourage students to recall (retrieval practice) and explain concepts that have been learned, while Dare cards contain tasks or challenges that require students to apply concepts, analyze problems, and connect the material to phenomena in everyday life. During the game, students discuss and provide reasons for their answers, creating a collaborative argumentation process that can strengthen conceptual understanding. In addition, feedback provided by teachers and peers helps students identify and correct potential misconceptions. Game activities that involve challenges, social interaction, and rewards for participation are also in line with the theory of learning motivation, which states that active involvement and enjoyable learning experiences can increase students' interest in participating in learning (Byusa et al., 2022; Ucu Cahyana, Mario Paristiowati, Muhammad Fajar Nurhadi, Siti Nuryana Hasyrin, 2017). Therefore, the use of Truth or Dare cards has the potential to support learning of the abstract and complex material of reaction rates.

Several studies have shown that the implementation of game-based media, including Truth or Dare cards, is effective in increasing student engagement and learning outcomes (Hu et al., 2022). According to (Widyana Salam & Alizar, 2025a), card media development*Truth or Dare*in the material Atomic Structure hasvery high level of eligibility based on the assessment of material experts and media experts, and obtained a very positive response from teachers and students, which shows that the media is practical and easy to use in learning. Furthermore, the research (Tamami & Rusmini, 2024) proves that this media is able to train students' argumentation skills in Buffer material. The research conducted by (Arifin & Irawan, 2021) found that the application of the Truth or Dare technique in the Discovery Learning model can improve students' logical thinking skills. These research results demonstrate that the use of Truth or Dare cards is relevant for chemistry learning, particularly in the Reaction Rate topic, which requires both conceptual understanding and mathematical analysis.

Several previous studies have reported the development of Truth or Dare cards in several chemistry topics, such as Atomic Structure and Buffer Solutions, as well as in the application of the

Discovery Learning model. These studies indicate that card-based media has the potential to support the chemistry learning process (Tamami & Rusmini, 2024; Widyana Salam & Alizar, 2025b). However, the development of Truth or Dare media on reaction rate material is still very limited. Reaction rate material has different characteristics from other chemistry materials because it includes abstract concepts regarding factors that influence reaction rate and the relationship between macroscopic, microscopic, and symbolic representations that require students' analytical skills (Putri & Muhtadi, 2018). In addition to the differences in material context, this study also developed a game mechanism specifically designed to support learning about reaction rates. Truth cards focused on conceptual questions that encouraged students to practice retrieval and explain concepts they had learned, while Dare cards contained tasks that required the application of concepts, problem analysis, and the association of material with everyday life phenomena. These activities align with the principles of game-based learning, which emphasize active student involvement in the learning process (Plass et al., 2015) as well as retrieval practice strategies that can strengthen knowledge retention through activities of recalling information that has been learned (Roediger & Karpicke, 2006). Media development was also carried out through a 3-D model adapted from the 4-D model that includes the Define, Design, and Develop stages, and was evaluated based on validity and practicality aspects. Differences in material characteristics, activity designs on the cards, and the focus of product evaluation indicate a research gap that has not been widely studied in previous studies. Therefore, this study aims to develop a Truth or Dare card learning media on the reaction rate material and test its feasibility based on validity and practicality aspects.

The development of Truth or Dare card media is expected to increase student motivation and engagement, facilitate understanding of abstract concepts, and provide innovative alternatives for teachers in implementing active learning strategies. In addition to providing solutions to learning problems in the classroom, this research also has the potential to enrich academic studies on the development of game-based learning media in the field of chemistry. Therefore, the author conducted a study with the title "Development of Truth or Dare Card-Based Learning Media on Reaction Rate Material at SMA Negeri 2 Sungai Raya".

Method

This study employed a Research and Development (R&D) approach using the Four-D (4-D) instructional development model proposed by Thiagarajan, Semmel, and Semmel (1974). The original model consists of four stages: Define, Design, Develop, and Disseminate. However, the present study was limited to the Define, Design, and Develop stages. Accordingly, the 4-D model was operationally adapted into a three-stage or 3-D framework. This adaptation was made because the study focused on identifying instructional needs, designing and developing the Truth or Dare card-based learning medium, validating the product, revising the prototype, and examining its practicality through small- and large-group trials. The Disseminate stage, which generally involves broader implementation, distribution, and institutional adoption, was beyond the scope, time frame, and resources of the present study. Therefore, the findings are limited to product validity and practicality and are not intended to demonstrate large-scale effectiveness or dissemination outcomes (Febrianto et al., 2025; Thiagarajan et al., 1974).

The developmental procedures were implemented systematically and iteratively. The Define stage involved curriculum analysis, student-characteristic analysis, concept analysis, task analysis, and the formulation of learning objectives. The Design stage included selecting the card format,

constructing the Truth and Dare questions, developing the rules of play, preparing the initial visual layout, and designing the validation and student-response instruments. The Develop stage comprised prototype production, expert validation, product revision, a small-group trial, and a large-group practicality trial. This sequence is consistent with contemporary instructional-design research, which emphasizes needs analysis, systematic prototype construction, expert validation, iterative revision, and user-acceptance testing before a learning product is implemented more broadly (Shakeel et al., 2023).

The use of a card-based game was also informed by research on gamification and game-based instructional design. Gamification integrates structured game elements into learning activities to improve participation, motivation, and engagement; however, its educational benefits depend on the alignment among learning objectives, game mechanics, learner characteristics, and assessment procedures (Dichev & Dicheva, 2017). Meta-analytic evidence indicates that well-designed gamified activities can positively affect cognitive, motivational, and behavioral learning outcomes (Bai et al., 2020; Sailer & Homner, 2020). Classroom research has also demonstrated that gamified quizzes can support engagement and learning when the questions, feedback, and game procedures remain closely connected to the intended learning outcomes (Sanchez et al., 2020). These considerations guided the design of the Truth or Dare cards, particularly the formulation of reaction-rate questions, the balance between challenge and accessibility, the clarity of the rules, and the provision of immediate learning feedback.

The methodological decisions were further informed by the authors' previous studies in educational product development and interactive learning. Koderi et al. (2023) developed and validated a local-wisdom-based instructional film through an R&D process involving expert assessment and user responses. Rokhman et al. (2024) developed an academic supervision model using the ADDIE framework and conducted expert validation followed by small- and large-group trials. Erlina et al. (2025) similarly used an R&D approach to design, validate, revise, and test a gender-responsive qira'ah learning module. These studies demonstrate the importance of systematic design, expert judgment, iterative revision, and field testing in establishing the feasibility of educational products.

In addition, Sari et al. (2024) reported that a team-games method supported students' motivation and learning outcomes, providing a relevant empirical basis for incorporating structured game activities into classroom learning. Al Khansa et al. (2024) emphasized that the implementation of an instructional model should be adjusted to learner characteristics, classroom conditions, and the intended educational outcomes. Drawing on these studies, the Truth or Dare card medium was designed not merely as an entertaining activity but as a structured instructional tool for encouraging active participation, discussion, conceptual recall, and engagement with reaction-rate concepts.

Because the Disseminate stage and an experimental effectiveness test were not conducted, this study does not claim that the developed medium improves students' conceptual understanding or learning achievement. It only establishes the validity of the product based on expert judgment and its practicality based on students' responses during limited field trials. Further research should implement the complete 4-D model and employ an experimental or quasi-experimental design to evaluate the medium's effectiveness.

Population and Sample

The study population was all eleventh-grade students of SMAN 2 Sungai Raya. This study was conducted through two trial stages. The first stage was a small-scale trial involving nine eleventh-grade students who were purposively selected based on their academic ability levels, namely three high-ability students, three medium-ability students, and three low-ability students. The second stage was a large-scale trial involving 27 other eleventh-grade students who did not participate in the small-scale trial. Thus, no students were involved in both trial stages, so that participants in the small-scale trial and the large-scale trial constituted separate and independent groups.

Research Procedures

The Define Stage aims to establish learning requirements through five steps: front-end analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. The Design stage includes the preparation of learning media designs, media content design, media display design, and research instrument development. The Develop stage includes expert validation, product revision, limited (small) trials, field (large) trials, product evaluation, and refinement.

Data collection technique

Data collection was conducted by the researcher in two stages, namely the needs analysis stage and the product evaluation stage. In the needs analysis stage, the researcher conducted observations and interviews with chemistry teachers and several students of class XI A of SMAN 2 Sungai Raya during pre-research activities. Observations were conducted to identify learning conditions, student characteristics, and learning media used in the classroom. Interviews were conducted to obtain information regarding students' difficulties in learning the reaction rate material, obstacles faced by teachers in the learning process, and the need for more interactive learning media. The results of the observations and interviews were used as a basis for designing the content, format, and game mechanisms on the Truth or Dare card media.

Product evaluation was conducted after the media was developed. Product evaluation data were collected using expert validation questionnaires and student response questionnaires. The validation questionnaire was administered to three material experts and three media experts to assess the product's feasibility based on aspects of content, presentation, language, and media design. Meanwhile, student response questionnaires were administered during small-scale trials and large-scale trials to assess the media's practicality in terms of appearance, ease of use, material presentation, and usefulness in supporting the learning process. All instruments used a five-point Likert scale (SS, S, CS, TS, STS).

Data Analysis Techniques

The validity of the media was analyzed based on the assessment results of material experts and media experts using a validation sheet with a 5-point Likert scale, namely Strongly Agree (SS) = 5, Agree (S) = 4, Quite Agree (CS) = 3, Disagree (TS) = 2, and Strongly Disagree (STS) = 1. The assessment was carried out on the content, presentation, and design aspects of the media. The validity percentage was calculated using the formula:

$$\text{Validity Percentage} = \frac{Jumlah\ skor\ yang\ diperoleh}{Skor\ maksimal} x100\%$$

Information:

- ΣX = the total score obtained from all validators on all assessment items.
- Xmax = maximum possible score, calculated from the number of assessment items x the highest score on the Likert scale (5) x the number of validators.

The use of validity percentages was chosen because it allows the assessment results from all validators to be converted into a uniform scale (0–100%), thus facilitating interpretation of the level of product feasibility and comparison between the aspects assessed.

The results of the validity percentage calculation are then categorized based on the criteria in Table 1:

Table 1. Validity Level Criteria

Percentage (%)	Criteria
81% - 100%	Very Valid
61% - 80%	Valid
41% - 60%	Quite Valid
21% - 40%	Less Valid
0% - 20%	Invalid

Source: (Azkiyah et al., 2022).

Practicality analysis was carried outbased on the results of the student response questionnaire and calculated using the percentage of student responses with the formula:

$$\text{Practicality Percentage} = \frac{\text{Jumlah Skor Yang Diperoleh}}{\text{Skor Maksimum}} \; X \; 100\%$$

The results of the analysis are then categorized based on the criteria of practicality level in Table 2:

Table 2. Practicality Level Criteria

Percentage (%)	Criteria
0% - 20%	Impractical
21% - 40%	Less practical
41% - 60%	Quite Practical
61% - 80%	Practical
81% - 100%	Very Practical

Source: (Azkiyah et al., 2022).

Results and Discussion

Results

This research is a research and development (R&D) study. The 3D method used includes Define, Design, and Develop, an adaptation of the 4D model (Thiagarajan, S., 1974). Data collection was conducted through expert validation involving three material expert validators and three media expert validators. All validators were selected based on the relevance of competencies to their respective assessment areas. Furthermore, the practicality of the learning media was tested through two stages, namely small group trials and large group trials. The small group trial involved 9 students of class XI A who were selected purposively to represent high, medium, and low abilities. The large group trial involved 27 students of class XI A of SMAN 2 Sungai Raya. The results of this study are in the form of a learning media product based on Truth or Dare Cards on the Reaction Rate material developed for class XI students at SMAN 2 Sungai Raya, with the following description.

Define Stage

The Define stage is carried out to establish and define the requirements needed to develop learning media. This stage includes five analytical steps: front-end analysis, learner analysis, task analysis, concept analysis, and formulation of learning objectives.

The results of the front-end analysis indicate that chemistry learning at SMAN 2 Sungai Raya is still dominated by lecture methods with the main learning resources being textbooks and practice questions. Based on the results of observations, students appear passive and tend to only listen and take notes on teacher explanations without adequate opportunities for discussion or participating in interactive learning activities. Interviews with chemistry teachers revealed that the Reaction Rate material is difficult for students to understand because it contains abstract concepts and mathematical calculations. The limited variety of learning media causes the delivery of material to be monotonous, so that students easily feel bored and their learning motivation decreases.

The results of student analysis through interviews with representatives of class XI A students representing high, medium, and low abilities showed that all students stated that the Reaction Rate material was difficult to understand, especially in the abstract concepts and mathematical calculations. Students expressed their hope that innovative, interactive, and fun learning media would be available to encourage their active involvement in the learning process.

Task analysis and concept analysis were conducted to map the Learning Outcomes (CP) and Learning Objectives (TP) for the Reaction Rate material for grade XI of the Independent Curriculum. The results of the analysis showed that the material focused on five factors that influence reaction rates, namely: (1) temperature, (2) concentration, (3) surface area, (4) pressure in gas reactions, and (5) catalysts. Based on the results of this analysis, learning objectives were formulated so that students are able to identify, explain, and analyze these factors and relate them to phenomena in everyday life.

Design Stage

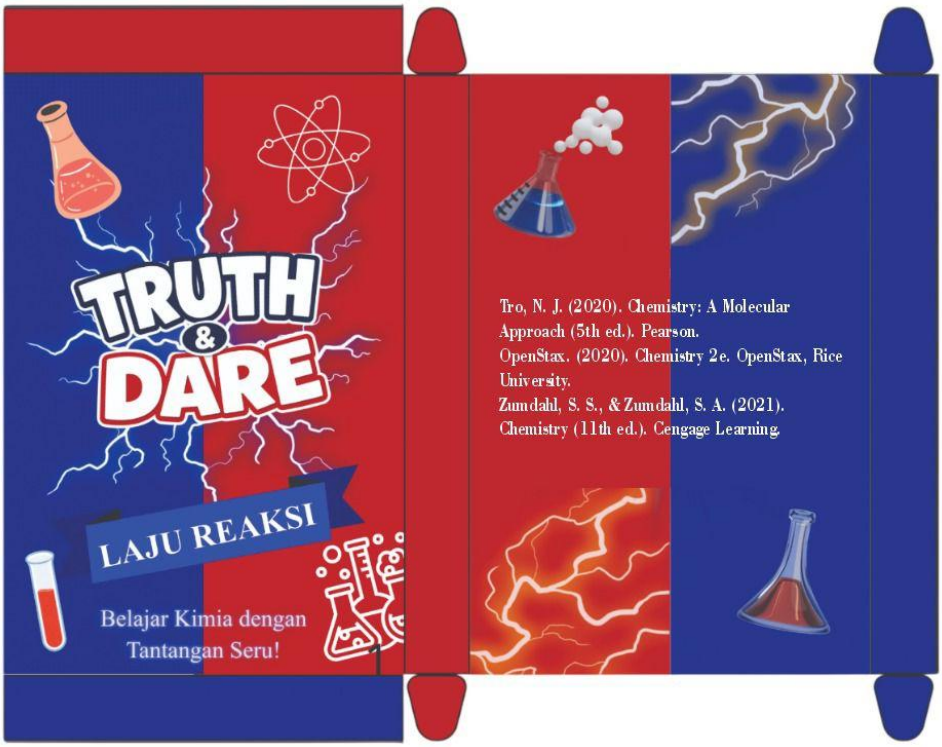
The design phase encompasses three main activities: developing research instruments, selecting media, and selecting card formats. The research instruments developed include a material expert validation sheet, a media expert validation sheet, and a student response questionnaire. The validation sheet is used to assess the appropriateness of the media in terms of content, presentation, language, and design, while the student response questionnaire is used to assess the practicality of the media after use in learning.

The media chosen is an educational game-based Truth or Dare Card consisting of 20 cards, namely 10 Truth cards containing conceptual questions and 10 Dare cards containing tasks or challenges related to the Reaction Rate material. The selection of this media is based on several considerations, namely: (1) students need interactive learning media to encourage active involvement in the learning process; (2) game-based media can increase students' motivation and interest in learning; and (3) the group game format is able to create a fun, collaborative learning atmosphere, and is centered on students.

The cards are designed to measure 6 x 9 cm using 260 gsm art carton and developed using the Canva app. The card design combines text, illustrations, and contrasting colors to differentiate between Truth and Dare cards. The media product also comes with a game guide that includes instructions for use, game rules, card drawing mechanisms, assessment procedures, and the teacher's role during the learning process.

Truth or Dare cards are used in group learning of 4–6 students. Before the game begins, the teacher explains the learning objectives, rules, and assessment procedures. Each group takes turns drawing one Truth or Dare card based on the draw. Truth cards contain conceptual questions that encourage students to identify, explain, and analyze the concept of reaction rate, while Dare cards contain tasks or challenges that require students to apply the concept in contextual situations, solve simple problems, or provide scientific explanations. Each answer or completion of the task receives direct feedback from the teacher and group members to strengthen conceptual understanding. The game lasts approximately 15–20 minutes, with the teacher acting as a facilitator who directs the discussion, ensures the involvement of all students, and ensures that each challenge remains relevant to the learning objectives and does not cause psychological discomfort. Thus, all activities on the Truth and Dare cards are designed to support the achievement of the learning objectives of the reaction rate material.

Truth or Dare cards are presented in the form of an educational game consisting of three main components: the Truth or Dare card box and the front of the Truth or Dare card. The card box serves as both a storage container and the media's identity. The front of the card displays the identity and media design, which is uniform for all cards. While the back of the card contains the card number, question, or challenge that must be completed by students. The appearance of each component of the Truth or Dare card media is presented in the following image.



Picture 1. Truth or Dare Card Box Display

Picture 2. Truth or Dare Card Front View

Picture 3. Back View of Truth or Dare Card

Develop Stage

The Development phase aims to produce a viable Truth or Dare Card product through expert validation, product revision, small group trials, and large group trials. In the validation phase, the validators provided several inputs for product refinement. From the material aspect, the validators suggested improving the wording of several questions for clarity, using more consistent chemical terms, and adjusting several questions to the learning objectives of reaction rates. From the media aspect, the validators suggested improving the text layout, increasing letter readability, adjusting color combinations for better reading comfort, and refining the media usage instructions for easier understanding by students.

Based on this feedback, revisions were made to the content and presentation of the media before the product was tested. These revisions included refining the wording of questions and challenges on the cards, adjusting the visual design, improving the layout, and adding information to the game guide. These revisions aimed to improve the clarity of the material, ease of use of the media, and the alignment of the game activities with the learning objectives. After all improvements were made, the product was revalidated and declared fit for use in the trial phase.

Validity of Truth or Dare Card Media

The validity of the Truth or Dare Card media was obtained through assessments by six validators, consisting of three material experts and three media experts. The validation instrument used a 1–5 Likert scale that covered several assessment aspects. In material validation, aspects assessed included the suitability of the material to the learning objectives, conceptual accuracy, language clarity, and the suitability of the cognitive level of the questions. In media validation, aspects assessed included visual appearance, readability, layout, ease of use, and quality of media presentation. In addition to providing quantitative scores, the validators also provided written comments and suggestions for improvement as part of the content validation process. The results of the assessments by the material expert and media expert validators are presented in Tables 3 and 4 below:

Table 3. Expert Assessment of Truth or Dare Card Material

Subject Matter Expert	Validity Percentage (%)	Criteria
Subject Matter Expert 1	100%	Very Valid
Subject Matter Expert 2	100%	Very Valid
Subject Matter Expert 3	90%	Very Valid
Average	96.66%	Very Valid

Based on Table 3, the results of the material expert assessment obtained an average validity percentage of 96.66%, categorized as very valid. Material Expert 1 and Material Expert 2 gave a perfect rating of 100%, while Material Expert 3 gave a rating of 90%.

Table 4. Truth or Dare Card Media Expert Assessment

Media Expert	Validity Percentage (%)	Criteria
Media Expert 1	100%	Very Valid
Media Expert 2	100%	Very Valid
Media Expert 3	90%	Very Valid
Average	96.66%	Very Valid

Based on Table 4, the results of the media expert assessment obtained an average validity percentage of 96.66%, categorized as very valid. Media Expert 1 and Media Expert 2 gave an assessment of 100%, while Media Expert 3 gave an assessment of 90%.

b. Practicality of Truth or Dare Card Media

Media practicality was measured through a student response questionnaire consisting of 12 statements using a Likert scale of 1–5. The questionnaire covered five assessment aspects, namely: (1) media appearance and design, (2) ease of use, (3) clarity of the material presented, (4) usefulness

of the media in learning, and (5) learning motivation felt by students. Data collection was carried out in two stages, namely a small-scale trial involving 9 students who were selected purposively to represent high, medium, and low ability groups, and a large-scale trial involving 27 class XI A students who did not participate in the small-scale trial. The results of student responses in both stages were used to assess the level of media practicality and are presented in Table 5 below:

Table 5. Student Response Results to Truth or Dare Cards

No	Trials	Number of Students	Percentage (%)	Criteria
1	Small Scale Trial	9	86.67%	Very Practical
2	Large-Scale Trial	27	89.26%	Very Practical

Based on Table 5, the small-scale trial obtained a practicality percentage of 86.67% and the large-scale trial obtained a practicality percentage of 89.26%. Both trials were included in the very practical category (81%–100%).

Discussion

The results of the study show that the Truth or Dare Card learning media for the Reaction Rate material developed meets two product development quality criteria, namely valid and practical. Based on the validity aspect, the assessments from material experts and media experts each obtained an average percentage of 96.66%, with a very valid category. The high validity of the material aspect indicates that the content of the Truth or Dare Card media has met the criteria for content feasibility, including the suitability of the material with learning outcomes and objectives, the accuracy of the reaction rate concept, the suitability of the cognitive level of the questions (C1–C3), and the relevance of the material to the context of everyday life. The formulation of questions on the Truth cards and tasks on the Dare cards based on concept analysis and task analysis also supports the suitability of the media content with the established learning objectives. Meanwhile, the high validity of the media aspect indicates that the visual appearance, layout, readability, illustrations, and physical format of the cards are considered suitable for use in learning. The use of a card size of 6 × 9 cm, 260 gsm art carton material, and different colors between the Truth and Dare cards are considered to support ease of use and identification of card types during learning activities. In addition, the revision process based on validator input contributed to improving the quality of the content and appearance of the media before being tested on students. These results are in line with research (Widyana Salam & Alizar, 2025b), which obtained a very valid category in the development of Truth or Dare card media for the Atomic Structure material. Similar findings were also reported by (Tamami & Rusmini, 2024), which shows that the Truth or Dare card media meets the validity criteria based on expert assessment. The similarity of the results indicates that the Truth or Dare card game-based media has the potential to be developed as a chemistry learning medium that is suitable for use based on the aspects of the suitability of the content and media design (Erika et al., 2023).

Based on the practicality aspect, the results of the small-scale trial (n = 9) obtained a student response percentage of 86.67%, while the large-scale trial (n = 27) obtained a percentage of 89.26%. Both results are included in the very practical category (81%–100%). These findings indicate that the Truth or Dare Card media received a positive response from students in both the small-scale and

large-scale trials. The high level of practicality of the media is supported by several factors. First, the simple game mechanism and clear instructions for use made it easy for students to understand the rules of the game. Second, the visually appealing and easy-to-use card design supported the smooth implementation of learning activities. Third, the material and questions related to everyday life phenomena helped students understand the contents of the cards more easily. In addition, the aspects of media usefulness and learning motivation received a positive response from students, indicating that the media was well received during the learning process (Ucu Cahyana, et al., 2017). This finding is in line with the practicality criteria put forward by (Azkiyah et al., 2022), which states that a product is categorized as practical if it can be used easily in the learning process without experiencing significant obstacles. Thus, the developed Truth or Dare Card media has a very good level of practicality based on student responses in both trial stages.

The results demonstrate that the Truth or Dare card-based learning medium satisfied the two quality criteria examined in this study: validity and practicality. Material and media experts each assigned an average validity score of 96.66%, indicating that the reaction-rate content, question formulation, cognitive levels, language, visual design, readability, layout, and physical format were appropriate for classroom use. The practicality scores of 86.67% in the small-group trial and 89.26% in the large-group trial produced an overall mean of approximately 87.97%, showing that students perceived the medium as understandable, attractive, useful, and easy to operate. These findings are theoretically consistent with research showing that game-based learning becomes educationally valuable when game mechanics, learning objectives, content, feedback, and learner characteristics are systematically aligned. Nevertheless, the high scores should be interpreted as evidence of expert-judged feasibility and student-perceived usability rather than evidence of improved achievement or conceptual understanding (Gui et al., 2023; Kalogiannakis et al., 2021).

The findings also correspond with recent Indonesian studies on game-based chemistry learning and educational-media development. Lutfi et al. (2021) found that gamified chemistry instruction could create a more enjoyable learning environment, while Zamhari et al. (2023) reported highly positive expert and user evaluations of the TAPUBA puzzle as an independent chemistry-learning medium. More specifically, Deaningtyas et al. (2024) developed an augmented-reality-supported medium for reaction-rate learning, demonstrating the continued need for instructional media that connect abstract chemical concepts with contextual and visual representations. Hanafi et al. (2025) further identified motivation and engagement as dominant outcomes in the development of chemistry gamification research, whereas Rumahorbo et al. (2025) showed that contextual educational games could facilitate students' understanding of reaction-rate concepts. The present study extends these local findings by offering a low-technology printed alternative that can be implemented without smartphones, internet access, or specialised digital infrastructure (Deaningtyas et al., 2024; Hanafi et al., 2025; Lutfi et al., 2021; Rumahorbo et al., 2025; Zamhari et al., 2023).

The findings have theoretical and pedagogical implications for game-based chemistry instruction. The Truth cards provide opportunities for retrieval, explanation, and reinforcement of previously learned concepts, whereas the Dare cards require students to apply concepts, interpret contextual problems, and communicate scientific reasoning. This distinction gives the two card types complementary cognitive functions rather than treating the game as a recreational addition to the lesson. The design is comparable to the *Compound Chain* card game, which demonstrated that

carefully structured matching and decision-making activities can support chemistry learning, and to broader evidence that different game-based pedagogies can produce different learning experiences depending on teacher facilitation and student participation. Reviews of non-digital and digital card games also indicate that simple card formats can support interaction, repeated practice, immediate feedback, and collaborative learning. Pedagogically, teachers should therefore use the cards as structured tools for review, formative assessment, group discussion, and concept application while continuing to provide scientific clarification, mathematical exercises, graphical interpretation, and laboratory or demonstration activities (Ding & Yu, 2024; Szilágyi et al., 2025; Tursyngozhayev et al., 2024).

At the institutional and policy levels, the product illustrates that meaningful instructional innovation does not always require expensive digital technology. Schools can support teachers in developing low-cost, curriculum-aligned learning media through chemistry-teacher working groups, professional learning communities, internal workshops, and collaborative lesson-design activities. However, institutional adoption should be accompanied by content review, media validation, preparation of sufficient card sets, teacher guidance, and procedures for ensuring equitable student participation. The novelty of this study lies in adapting the Truth or Dare format specifically to reaction-rate concepts, differentiating the cognitive functions of Truth and Dare activities, integrating familiar everyday phenomena, and evaluating the product through expert validation and two independent user trials. Its principal contribution is therefore a systematically developed and highly practical prototype for Indonesian senior high school chemistry, rather than proof that the product is superior to conventional instruction. This cautious interpretation is consistent with evidence that the educational contribution of games depends more on instructional design and implementation quality than on the mere presence of game elements (Gui et al., 2023; Kalogiannakis et al., 2021).

Several limitations restrict the interpretation of the findings. The study involved only 36 students from one class and one school, used purposive selection in the small-group trial, relied substantially on self-reported student responses, and did not include a control group, pre-test, post-test, delayed-retention test, or direct observation of implementation fidelity. The percentage-based validation procedure also did not examine inter-rater agreement or report indices such as Aiken's V. In addition, most card activities were limited to cognitive levels C1–C3, and the Disseminate stage of the original 4-D model was not implemented. Future research should therefore involve larger multisite samples, independent treatment and comparison groups, validated motivation and engagement scales, classroom-observation data, teacher-usability assessments, and tests of conceptual understanding, achievement, argumentation, and delayed retention. Further development should incorporate higher-order tasks involving reaction-rate graphs, experimental data, collision theory, symbolic representations, and scientific claims, followed by broader dissemination and cost-effectiveness evaluation before institutional adoption is recommended (Ding & Yu, 2024; Rumahorbo et al., 2025; Szilágyi et al., 2025). (ResearchGate

Conclusion

This study aimed to develop a Truth or Dare card-based learning medium for teaching reaction-rate concepts to senior high school students and to determine its validity and practicality through expert evaluation and limited field trials. Developed using a three-stage framework adapted from the Four-D model (Define, Design, and Develop) the resulting instructional medium demonstrated a very high

level of feasibility. Material and media experts each assigned an average validity score of 96.66%, indicating that the scientific content, alignment with learning objectives, cognitive appropriateness of the questions, visual design, readability, layout, and operational procedures were suitable for classroom use. Furthermore, student responses produced practicality scores of 86.67% in the small-group trial and 89.26% in the large-group trial, confirming that the medium was understandable, engaging, accessible, and operationally manageable. These findings directly address the research objectives by establishing that the developed product satisfies the essential criteria of validity and practicality as an alternative instructional resource for reaction-rate learning. Theoretically, this study extends the application of game-based learning principles in chemistry education by demonstrating how conceptual questions, contextual challenges, collaborative interaction, retrieval practice, and immediate feedback can be systematically integrated into a structured card-based medium. Methodologically, it illustrates the value of combining needs analysis, iterative product design, expert judgment, revision, and user-response evaluation in educational media development. Practically, the medium offers chemistry teachers an interactive strategy for reducing classroom monotony, encouraging active participation, and facilitating discussion of abstract reaction-rate concepts. Nevertheless, the findings should be interpreted within several limitations, including the involvement of students from a single school, the relatively small sample, the restricted duration of implementation, the omission of the Disseminate stage, and the absence of an experimental assessment of learning effectiveness. Future studies should therefore implement the complete Four-D model, involve larger and more diverse participant groups, examine long-term classroom implementation, and employ experimental or quasi-experimental designs to investigate effects on conceptual understanding, learning achievement, motivation, argumentation, and knowledge retention. Ultimately, this study provides a credible foundation for advancing pedagogically aligned game-based media and supports the broader development of active, meaningful, and evidence-informed chemistry learning.

Reference

Al Khansa, E., Pahrudin, A., Jatmiko, A., Sufian, M., & Azad, I. (2024). The integrated learning model in Islamic religious education in junior high school. *Southeast Asian Journal of Islamic Education, 7*(2), 69–85. https://doi.org/10.21093/sajie.v7i2.9356

Arifin, R., & Irawan, E. (2020). The effectiveness of discovery learning with truth or dare technique in improving students' logical thinking ability. *INSECTA: Integrative Science Education and Teaching Activity Journal, 1*(2), 121–129. https://doi.org/10.21154/insecta.v1i2.2388

Aulia, A. N., Saputro, S., & Saputro, A. N. C. (2018). Upaya meningkatkan aktivitas dan prestasi belajar kimia pada materi pokok laju reaksi melalui model pembelajaran kooperatif tipe make a match pada siswa kelas XI IPA 5 SMA Negeri Kebakkramat tahun pelajaran 2016/2017. *Jurnal Pendidikan Kimia, 7*(2), 177–182. https://doi.org/10.20961/jpkim.v7i2.25762

Azkiyah, A., Wijoyo, S. H., & Amalia, F. (2022). Pengembangan media pembelajaran berbasis website pada mata pelajaran dasar desain grafis menggunakan model pengembangan Four-D: Studi pada SMK Negeri 1 Rembang. *Jurnal Teknologi Informasi dan Ilmu Komputer, 9*(4), 875–882. https://doi.org/10.25126/jtiik.2022945299

Azzahra, L. L., & Angeli, R. A. (2025). Implikasi perkembangan afektif, kognitif, dan psikomotorik serta moral dan spiritual peserta didik dalam pembelajaran pada sekolah dasar. *Mesada: Journal of Innovative Research, 1*(2), 202–210. https://doi.org/10.61253/vpzm4g97

Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review, 30*, Article 100322. https://doi.org/10.1016/j.edurev.2020.100322

Byusa, E., Kampire, E., & Mwesigye, A. R. (2022). Game-based learning approach on students' motivation and understanding of chemistry concepts: A systematic review of literature. *Heliyon, 8*(5), Article e09541. https://doi.org/10.1016/j.heliyon.2022.e09541

Cahyana, U., Paristiowati, M., Nurhadi, M. F., & Hasyrin, S. N. (2017). Studi tentang motivasi belajar siswa pada penggunaan media mobile game-based learning dalam pembelajaran laju reaksi kimia. *JTP: Jurnal Teknologi Pendidikan, 19*(2), 143–155. https://doi.org/10.21009/jtp.v19i2.6323

Deaningtyas, S. A., Purwandari, A., Sentanu, N. A. Z., Rafsanjani, E. R., Kamaliyah, N. L., & Setiawan, N. C. E. (2024). Development of CHEMISTER as chemistry education media with socioscientific issues approach integrated with augmented reality to support education for sustainable development. *J-PEK (Jurnal Pembelajaran Kimia), 9*(2), 106–115. https://doi.org/10.17977/um026v9i22024p106-115

Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain—A critical review. *International Journal of Educational Technology in Higher Education, 14*, Article 9. https://doi.org/10.1186/s41239-017-0042-5

Ding, A.-C. E., & Yu, C.-H. (2024). Serious game-based learning and learning by making games: Types of game-based pedagogies and student gaming hours impact students' science learning outcomes. *Computers & Education, 218*, Article 105075. https://doi.org/10.1016/j.compedu.2024.105075

Elmali, S., Freund, L., & Tiemann, R. (2026). A systematic literature review of game-based approaches in chemistry education (2014–2024). *Chemistry Education Research and Practice, 27*(1), 31–44. https://doi.org/10.1039/D5RP00248F

Erika, F., Aksha, O., Ariningtyas, D. N., Qolbiah, I., & Safrida, A. N. (2023). Game-based learning media to improve students' understanding in chemistry learning. *Hydrogen: Jurnal Kependidikan Kimia, 11*(3), 233–241. https://doi.org/10.33394/hjkk.v11i3.7922

Erlina, E., Koderi, K., & Sufian, M. (2025). Designing a gender-responsive qira'ah learning module: Bridging equality and inclusivity in Islamic higher education. *Jurnal Ilmiah Islam Futura, 25*(1), 239–262. https://doi.org/10.22373/jiif.v25i1.29305

Febrianto, M. D., Firdaus, R., & Sagala, M. K. (2025). Pengembangan media pembelajaran interaktif berbantuan authoring tools pada pembelajaran informatika kelas X SMA. *Jurnal PPS-TP: Jurnal Pendidikan Analisis, Aplikasi Teori dan Hasil Penelitian, 13*(1), 62–77.

Gui, Y., Cai, Z., Yang, Y., Kong, L., Fan, X., & Tai, R. H. (2023). Effectiveness of digital educational game and game design in STEM learning: A meta-analytic review. *International Journal of STEM Education, 10*, Article 36. https://doi.org/10.1186/s40594-023-00424-9

Hanafi, A. A., Liliasari, & Munawaroh, H. S. H. (2025). Trends and impact gamification in chemistry learning: A bibliometric analysis. *Indonesian Journal of Educational Research and Review, 8*(1), 80–91. https://doi.org/10.23887/ijerr.v8i1.83305

Harahap, A. A. S., Salsabila, Y., Fitria, N., & Harahap, N. D. (2023). Pengaruh perkembangan kemampuan pada aspek kognitif, afektif, dan psikomotorik terhadap hasil belajar. *Algebra: Jurnal Pendidikan, Sosial dan Sains, 3*(1). https://doi.org/10.58432/algebra.v3i1.741

Hu, Y., Gallagher, T., Wouters, P., van der Schaaf, M., & Kester, L. (2022). Game-based learning has good chemistry with chemistry education: A three-level meta-analysis. *Journal of Research in Science Teaching, 59*(9), 1499–1543. https://doi.org/10.1002/tea.21765

Kalogiannakis, M., Papadakis, S., & Zourmpakis, A.-I. (2021). Gamification in science education: A systematic review of the literature. *Education Sciences, 11*(1), Article 22. https://doi.org/10.3390/educsci11010022

Koderi, K., Sufian, M., & Erlina, E. (2023). Developing Lampung local wisdom film of Arabic communication skills for Madrasah Tsanawiyah students. *International Journal of Information and Education Technology, 13*(12), 2004–2013. https://doi.org/10.18178/ijiet.2023.13.12.2015

Lutfi, A., Aini, N. Q., Amalia, N., Umah, P. A., & Rukmana, M. D. (2021). Gamifikasi untuk pendidikan: Pembelajaran kimia yang menyenangkan pada masa pandemi COVID-19. *Jurnal Pendidikan Kimia Indonesia, 5*(2), 94–101. https://doi.org/10.23887/jpk.v5i2.38486

Nurtanto, M., & Sofyan, H. (2015). Implementasi problem-based learning untuk meningkatkan hasil belajar kognitif, psikomotor, dan afektif siswa di SMK. *Jurnal Pendidikan Vokasi, 5*(3), 352–364. https://doi.org/10.21831/jpv.v5i3.6489

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Putri, D. P. E., & Muhtadi, A. (2018). Pengembangan multimedia pembelajaran interaktif kimia berbasis Android menggunakan prinsip Mayer pada materi laju reaksi. *Jurnal Inovasi Teknologi Pendidikan, 5*(1), 38–47. https://doi.org/10.21831/jitp.v5i1.13752

Roediger, H. L., III, & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science, 17*(3), 249–255. https://doi.org/10.1111/j.1467-9280.2006.01693.x

Rokhman, R., Diana, N., Etek, Y., Koderi, K., & Sufian, M. (2024). The development of a scientific-based academic supervision management model. *AL-ISHLAH: Jurnal Pendidikan, 16*(2), 1383–1398. https://doi.org/10.35445/alishlah.v16i2.4626

Rumahorbo, S. M., Aznam, N., & Anding, I. (2025). Understanding the concept of reaction rate of high school students through educational games based on a contextual approach. *Jurnal Pendidikan dan Pengajaran, 58*(2), 374–386. https://doi.org/10.23887/jpp.v58i2.94674

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review, 32*(1), 77–112. https://doi.org/10.1007/s10648-019-09498-w

Salam, W., & Alizar. (2025). Pengembangan permainan kartu Truth or Dare (TOD) kimia sebagai media pembelajaran berbasis game-based learning pada materi struktur atom untuk fase E SMA/MA. *Journal of Global Research Education, 2*(2), 86–96. https://doi.org/10.62194/tg71a580

Sanchez, D. R., Langer, M., & Kaur, R. (2020). Gamification in the classroom: Examining the impact of gamified quizzes on student learning. *Computers & Education, 144*, Article 103666. https://doi.org/10.1016/j.compedu.2019.103666

Sari, N., Muslim, A. B., Sodiq, A., Erlina, E., & Sufian, M. (2024). Influence of teams games method by Kokami and learning motivation on Arabic language learning outcomes. *Loghat Arabi: Jurnal Bahasa Arab dan Pendidikan Bahasa Arab, 5*(1), 75–104. https://doi.org/10.36915/la.v5i1.180

Shakeel, S. I., Al Mamun, M. A., & Haolader, M. F. A. (2023). Instructional design with ADDIE and rapid prototyping for blended learning: Validation and its acceptance in the context of TVET Bangladesh. *Education and Information Technologies, 28*(6), 7601–7630. https://doi.org/10.1007/s10639-022-11471-0

Szilágyi, S., Körei, A., & Vaičiulytė, I. (2025). The role of non-digital and digital UNO-type card games as learning media in different levels of mathematics education: A systematic review. *Education Sciences, 15*(8), Article 1030. https://doi.org/10.3390/educsci15081030

Tamami, H., & Rusmini, R. (2024). Effectiveness of truth or dare game media to train students' argumentation skills on buffer solution material. *Asian Journal of Science Education, 6*(2), 102–113. https://doi.org/10.24815/ajse.v6i2.41491

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Leadership Training Institute/Special Education, University of Minnesota.

Tursyngozhayev, K., Kavak, N., & Akhmetov, N. K. (2024). Enhancing chemistry education for students through a novel card game: Compound Chain. *Journal of Chemical Education, 101*(3), 1367–1372. https://doi.org/10.1021/acs.jchemed.3c00983

Zamhari, M., Hanif, A., & Ridzaniyanto, P. (2023). Development of TAPUBA puzzle as an independent learning medium for the periodic system of elements. *Jurnal Inovasi Pendidikan Kimia, 17*(1), 41–48. https://doi.org/10.15294/jipk.v17i1.35560