Jurnal Riset Pendidikan Kimia (JRPK)

Volume 16 Issue 1, June 2026 e-ISSN: 2252 - 5378
https://doi.org/10.21009/JRPK.161.05

Received	: 6 June 2026
Revised	: 26 June 2026
Accepted	: 29 June 2026
Published	: 30 June 2026

Development of Canva-Assisted Interactive Learning Media Based on Guided Discovery Learning on Chemical Reactions for Phase E Senior High School Students

Ezi Fitri Yani[1], Nofri Yuhelman[2]*

[1,2]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Barat, Padang 25131, Sumatera Barat, Indonesia

Email: nofriyuhelman@unp.ac.id *

Abstract

This study aimed to develop Canva-assisted interactive learning media based on the Guided Discovery Learning model for teaching chemical reactions to Phase E senior high school students. The increasing integration of digital technology in education requires instructional media that promote active learning and enhance students' conceptual understanding. This study employed a Research and Development (R&D) method using the 4-D model, consisting of the define, design, develop, and disseminate stages, although the research was limited to the develop stage. The novelty of this study lies in integrating Canva-assisted interactive learning media with Guided Discovery Learning in Phase E chemistry learning under the Merdeka Curriculum. The developed media was validated by five experts, while practicality was evaluated by two teachers and 32 Phase E students using validation sheets and practicality questionnaires. Validity was analyzed using Aiken's V, and practicality was determined through percentage analysis. The results showed an average Aiken's V value of 0.92, indicating high validity, while practicality scores reached 96% from teachers and 93% from students. These findings provide empirical evidence that the developed media is valid, highly practical, and suitable as an alternative instructional resource for chemistry learning. This media is therefore recommended for use by teachers as an innovative and engaging tool to support the implementation of student-centered chemistry instruction in senior high schools.

Keywords: 4-D model, Aiken's V, Merdeka Curriculum, Phase E chemistry

Introduction

Education plays a crucial role in equipping individuals with the knowledge, skills, and competencies needed to adapt to the demands of an increasingly dynamic society and the rapid advancement of technology. In the context of twenty-first-century learning, students are expected to develop essential competencies, including critical thinking, creativity, collaboration, communication, and digital literacy (Mahrunnisya, 2023). One instructional approach that supports the development of these competencies is the integration of interactive digital media with Guided Discovery Learning, which encourages students to actively construct knowledge through meaningful learning experiences (Mayer, 2021) . The use of digital technology in education also enhances instructional quality by delivering learning materials through various multimedia formats, such as text, images, audio, video, animations, and graphics. These multimedia features promote active learner engagement, strengthen conceptual understanding, increase learning motivation, and contribute to improved academic performance. In chemistry education, interactive multimedia is particularly valuable because it helps students visualize abstract concepts and supports a deeper understanding of scientific phenomena (Triyasmina et al., 2022).

Chemistry is often regarded as one of the most challenging subjects by senior high school students because learning its concepts requires them to connect three levels of chemical representation: macroscopic phenomena, submicroscopic particle interactions, and symbolic expressions (Priliyanti et al., 2021). Among the fundamental topics introduced in Phase E is chemical reactions, which require students to interpret observable changes in matter and relate them to the underlying reaction processes and chemical equations. The abstract nature and interconnectedness of these concepts frequently make it difficult for students to develop a comprehensive understanding of the topic.

A needs analysis involving 85 students from SMAN 1 Bukittinggi, SMAN 2 Bukittinggi, and SMAN 3 Bukittinggi showed that 85% of the respondents experienced difficulties in learning chemical reactions. The main challenges identified included the large number of chemical formulas (83.3%), the mathematical calculations required (48.3%), the abstract characteristics of the concepts (23%), and the limited availability of learning resources (16.7%). The survey also revealed that all students preferred the use of instructional media during classroom learning, while 79.3% expressed greater interest in media integrating visual and audiovisual elements, such as images, audio, videos, and animations. Interviews with chemistry teachers from the three schools indicated that chemical reaction lessons were predominantly delivered through lectures and classroom discussions supported by printed textbooks, videos, and PowerPoint presentations. Although these resources were regularly used, they were considered insufficient for encouraging active student engagement and independent learning. These findings highlight the need to develop interactive instructional media that can facilitate student-centered learning and promote greater learner autonomy.

One potential solution to overcome these learning challenges is the use of interactive learning media. By integrating multimedia components, such as text, images, audio, videos, and animations, interactive media create learning environments that encourage students to actively engage with instructional content through meaningful learning activities. Previous studies have shown that interactive learning media can enhance students' learning motivation, facilitate the understanding of abstract concepts, and improve academic performance (Mayer, 2021; Triyasmina et al., 2022). Moreover, interactive media developed based on the Guided Discovery Learning approach have been reported to possess high levels of validity and practicality in chemistry instruction (Nurhairunnisah et al., 2022). Interactive media also promote independent learning by enabling students to access learning materials anytime and anywhere through digital devices, including smartphones and laptops. In the present study, Canva was selected as the development platform because its interactive design features enable the creation of visually appealing, engaging, and easily accessible learning media (Ikhwan, 2022).

Developing a sound understanding of chemical reactions requires learning experiences that actively involve students in constructing their own knowledge rather than passively receiving information from teachers. Therefore, selecting an appropriate instructional model is crucial for helping students achieve meaningful conceptual understanding. Guided Discovery Learning is well aligned with the principles of the Merdeka Curriculum, as it encourages students to explore and discover scientific concepts through a structured process of guided inquiry (Kristalia, 2021). Throughout the learning process, students are encouraged to observe phenomena, analyze information, and draw conclusions independently with appropriate teacher guidance. This active learning process has been shown to strengthen conceptual understanding and promote meaningful learning in chemistry (Astra & Wahidah, 2017; Lestari, 2017).

Previous studies have highlighted the effectiveness of integrating interactive learning media with the Guided Discovery Learning approach in chemistry education. Nurhairunnisah et al. (2022), for instance, reported that interactive media developed using the Guided Discovery Learning framework for electrolyte and nonelectrolyte solutions demonstrated high levels of validity and practicality. Similarly, Harahap and Siregar (2020) found that interactive learning media enhanced students' learning motivation and improved their academic achievement in chemistry. Although these findings support the effectiveness of interactive media, most previous studies have focused on chemistry topics other than chemical reactions. Consequently, evidence regarding the development and implementation of Guided Discovery Learning-based interactive learning media for teaching chemical reactions remains limited. Furthermore, studies specifically designed for Phase E senior high school students are still scarce. Therefore, this study was conducted to develop Guided Discovery Learning-based interactive learning media on chemical reactions as a valid and practical instructional resource to support students' conceptual understanding.

In response to the limited research in this area, this study developed Canva-assisted interactive learning media based on the Guided Discovery Learning approach for teaching chemical reactions to Phase E senior high school students. The study further assessed the validity and practicality of the developed media to establish its suitability as an instructional resource for chemistry learning.

Method

This research adopted the Research and Development (R&D) approach to develop Canva-assisted interactive learning media based on the Guided Discovery Learning model for teaching chemical reactions in Phase E senior high school. The development procedure followed the 4-D model proposed by Thiagarajan et al. (1974), which consists of the define, design, develop, and disseminate stages. Due to limitations in scope and time, this study was conducted only up to the develop stage.

The define stage aimed to identify instructional needs through several preliminary analyses, including front-end analysis, learner analysis, task analysis, concept analysis, and learning objective analysis. Information was gathered using student needs analysis questionnaires and interviews with chemistry teachers to identify the learning difficulties encountered in chemical reaction topics. The results of these analyses served as the foundation for designing the learning media. During the design stage, the interactive learning media were developed using Canva by integrating various multimedia elements, such as text, images, audio, videos, animations, guiding questions, and interactive quizzes. These components were systematically organized according to the learning phases of the Guided Discovery Learning model. In the develop stage, the initial product underwent expert validation to evaluate its validity and feasibility as a learning resource. Suggestions and feedback provided by the validators were then used to revise and refine the media before proceeding to practicality testing.

The validation process involved five expert validators, comprising two senior high school chemistry teachers from SMAN 2 Bukittinggi and three chemistry education lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. These validators were selected purposively based on their expertise and professional experience in chemistry education and instructional media development. The involvement of five validators was intended to strengthen the objectivity of the content validation through expert triangulation while reducing the possibility of subjective bias that may arise from evaluations conducted by only a few reviewers. Two research instruments were employed in this study, namely a validation sheet and a practicality questionnaire. The validation sheet was designed to evaluate the developed media in terms of content accuracy, presentation, language, and visual appearance. Meanwhile, the practicality questionnaire was administered to teachers and students to assess the ease of use, usefulness, and applicability of the media during classroom instruction. Before being administered, both instruments were examined and validated by the research supervisors to ensure their content validity, clarity, relevance, and appropriateness for data collection.

The study produced both qualitative and quantitative data. Qualitative data consisted of comments, suggestions, and recommendations obtained from the validators, teachers, and students regarding the developed interactive learning media. Quantitative data were collected from the scores assigned by validators, teachers, and students using a five-point Likert scale. The validity of the developed media was analyzed using Aiken's V coefficient, calculated according to the following formula:

$$V = \frac{\sum s}{[n(c-1)}$$
$$s = r - l_0$$

Table 1. Validity Criteria Based on Aiken's V

Aiken's V Scale	Validity Category
< 0.8	Invalid
>0.8	Valid

Source: (Aiken, 1985)

The practicality of the interactive learning media was determined using the following equation:

$$NP = \frac{R}{SM} \times 100$$

Table 2. Practicality Criteria

Score Range	Practicality
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Quite Practical
55% - 59%	Less Practical
≤54%	Impractical

Source: (Purwanto, 2010)

Results and Discussion

This study resulted in the development of Canva-assisted interactive learning media based on the Guided Discovery Learning model on chemical reactions for Phase E senior high school students. The media was developed using the 4-D model, which comprises four stages: define, design, develop, and disseminate. Nevertheless, due to time and research scope limitations, the development process was carried out only up to the develop stage. Therefore, this study focused on evaluating the validity and practicality of the developed media as an instructional resource for chemistry learning.

The define stage

Front-end analysis

To determine the instructional needs in chemistry learning, data were gathered through interviews with chemistry teachers and questionnaires administered to students. The needs analysis revealed that chemical reactions remain one of the most challenging topics for students. A total of 85% of the respondents reported difficulties in understanding chemical reaction concepts. The primary challenge identified was the large number of chemical formulas (83.3%), followed by mathematical calculations (48.3%) and the abstract nature of the topic (23%). These findings highlight the need for interactive learning media that can facilitate students' conceptual understanding and improve the learning of chemical reactions.

Learner analysis

The learner analysis was conducted to examine students' characteristics and learning preferences. The results showed that 79.3% of students preferred technology-supported instructional media incorporating multimedia elements, such as images, videos, and animations. The analysis also revealed that 85% of the students experienced difficulties in understanding chemical reaction concepts. These findings were used as the basis for designing interactive learning media that address students' learning needs and characteristics while facilitating a better understanding of chemical reactions.

Task analysis

The task analysis was carried out by referring to the learning outcomes and learning objectives specified in the Merdeka Curriculum. The analysis identified the essential competencies that students were expected to achieve, including recognizing the characteristics and classifications of chemical reactions, writing chemical equations, and balancing chemical equations. These competencies served as the basis for determining the scope, sequence, and organization of the learning content incorporated into the developed interactive learning media.

Concept analysis

The concept analysis was conducted to determine the essential concepts that students needed to master in the topic of chemical reactions. The analysis indicated that many of these concepts are abstract and involve processes occurring at the molecular level, making them difficult to understand through verbal explanations alone. Therefore, the interactive learning media was designed by integrating visual and multimedia elements, including images, animations, videos, and multiple chemical representations, to support students in constructing a deeper conceptual understanding.

Learning objectives analysis

The learning objectives were formulated based on the results of the task and concept analyses. The interactive learning media was designed by incorporating the Guided Discovery Learning approach to encourage students' active participation in constructing knowledge through guided discovery activities. This approach also promotes curiosity, responsibility, and independent learning while helping students develop a deeper understanding of chemical reaction concepts. Accordingly, the developed media was intended to facilitate active, meaningful, and student-centered learning experiences.

The design stage

The design stage involved developing and organizing the interactive learning media based on the findings obtained during the define stage. The media was designed by integrating various multimedia elements, including images, instructional videos, animations, and interactive learning activities. These components were systematically arranged according to the phases of the Guided Discovery Learning approach while considering students' characteristics and learning needs.

Motivation and Problem Presentation

During the Motivation and Problem Presentation stage, students were introduced to contextual images and problem-based questions related to the characteristics and types of chemical reactions. These learning activities were intended to stimulate students' interest and encourage them to observe the presented phenomena, analyze the available information, and propose initial hypotheses to explain the observed problems. An illustration of the Motivation and Problem Presentation stage is presented in Figure 1.

Figure 1. The Motivation and Problem Presentation Stage

Data Collection

During the Data Collection stage, students were encouraged to work collaboratively to gather and analyze information relevant to the proposed hypotheses. The interactive learning media supported this process by providing various multimedia resources, including explanatory text, images, audio, instructional videos, and animations, to facilitate students' understanding of the characteristics and types of chemical reactions. An example of the Data Collection stage is presented in Figure 2.

Figure 2. The Data Collection Stage

Data Processing

During the Data Processing stage, students analyzed and organized the information collected in the previous stage to construct an understanding of the concepts being learned. Their understanding was then evaluated through a series of questions based on the collected information and the identified chemical reaction concepts. An illustration of the Data Processing stage is presented in Figure 3.

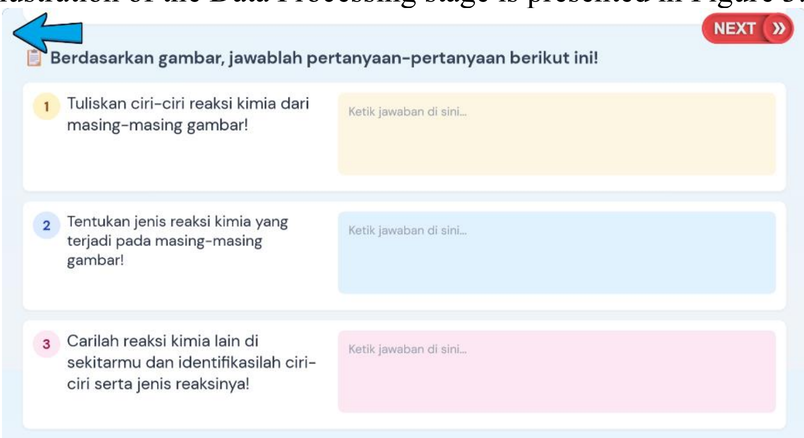

Figure 3. The Data Processing Stage

Verification

During the Verification stage, students evaluated the initial hypotheses formulated in the Motivation and Problem Presentation stage by comparing them with the evidence obtained from the data analysis and the concepts they had learned. When the proposed hypotheses were not supported by the findings, students were encouraged to revise them and formulate more appropriate conclusions. An illustration of the Verification stage is presented in Figure 4.

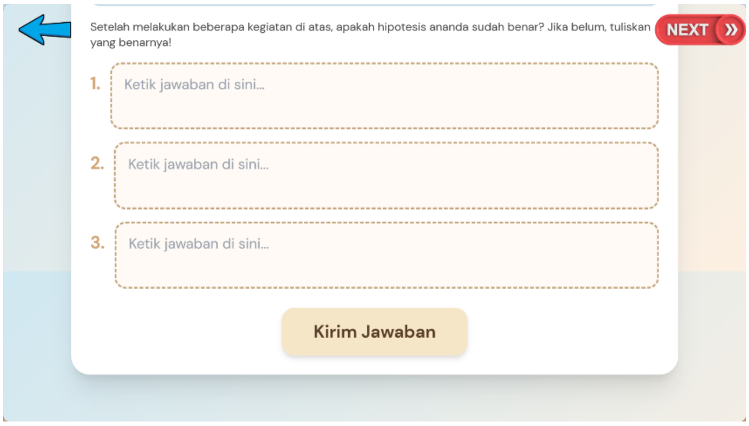

Figure 4. The Verification Stage

Closure

During the Closure stage, students were guided to synthesize the knowledge acquired throughout the learning process by formulating conclusions based on the concepts explored in the previous stages. To support this activity, the interactive learning media provided guiding questions that helped students identify the key concepts and summarize the learning outcomes. An illustration of the Closure stage is presented in Figure 5.

Figure 5. The Closure Stage

The develop stage

Validity assessment

The developed interactive learning media was evaluated through an expert validation process to determine its validity and suitability for instructional use. The validation involved five experts, comprising two senior high school chemistry teachers and three chemistry lecturers. The evaluation results were analyzed using Aiken's V coefficient. The findings indicated that the developed Guided Discovery Learning-based interactive learning media achieved an overall Aiken's V value of 0.92, placing it in the valid category. This result demonstrates that the media fulfilled the required standards in terms of content accuracy, presentation, language, and visual design.

The obtained Aiken's V value of 0.92 is comparable to those reported in previous studies on the development of chemistry learning media. Fadhilah and Yerimadesi (2025) reported an Aiken's V value of 0.902 for a Guided Discovery Learning-based interactive acid–base e-module, indicating that the developed e-module met the validity criteria. Likewise, Putri and Guspatni (2024) reported Aiken's V values of 0.93, 0.94, and 0.92 for the content, construct, and media aspects, respectively, in the development of a PowerPoint-iSpring learning media integrated with prompting questions. The similarity of these validity indices indicates that chemistry learning media developed through a systematic design process and validated by experts consistently achieve high levels of validity.

The detailed results of the expert validation are presented in Table 1, while their graphical representation is shown in Figure 6.

Table 3. Recapitulation of Media Validity Assessment Results

No	Assessed Aspect	Aiken's V	Validity Category
1	Content Component	0,91	Valid
2	Presentation Component	0,94	Valid
3	Language Component	0,92	Valid
4	Display Component	0,87	Valid
	Overall Average	0,92	Valid

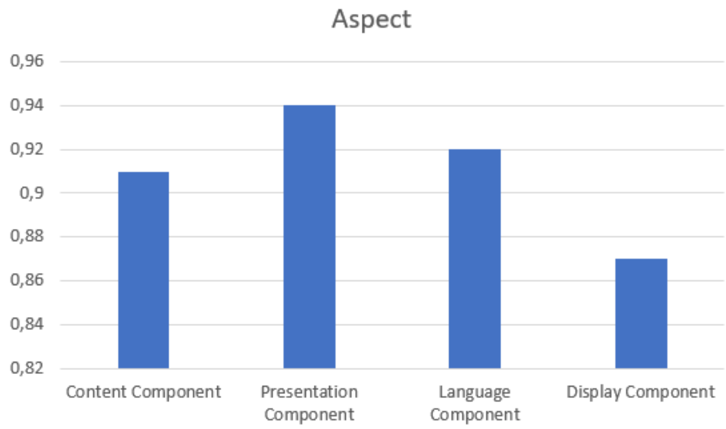

Figure 6. Graphical Representation of the Expert Validation Results of the Developed Interactive Learning Media

The expert validation results showed that the developed interactive learning media achieved an overall Aiken's V coefficient of 0.92, indicating a high level of validity. This finding demonstrates that the developed media is appropriate for chemistry instruction because it aligns with curriculum objectives, intended learning outcomes, students' characteristics, and the instructional phases of the Guided Discovery Learning model.

Among the assessed aspects, the presentation component obtained the highest validity score (Aiken's V = 0.94). This finding indicates that the organization of learning materials, learning activities, and instructional sequence successfully reflected the stages of Guided Discovery Learning. The systematic arrangement of learning activities enables students to construct concepts gradually through observation, investigation, experimentation, and guided problem-solving. Such a learning sequence is consistent with the fundamental principles of Guided Discovery Learning, which emphasize active knowledge construction through teacher guidance. Consequently, experts considered the presentation of the media to be pedagogically appropriate for facilitating meaningful chemistry learning. These findings are in agreement with Putri and Guspatni (2024), who reported that Guided Discovery Learning-based multimedia effectively promotes meaningful learning and active concept construction among students.

The language component achieved an Aiken's V value of 0.92, indicating that the language used throughout the media was clear, communicative, and appropriate for the cognitive development of Phase E senior high school students. The use of understandable language is essential because it minimizes misconceptions, facilitates students' comprehension of chemistry concepts, and supports independent learning. This finding is consistent with the recommendations of Depdiknas (2008), which emphasize that instructional materials should employ language that is accurate, understandable, and appropriate for students' developmental level.

The content component obtained an Aiken's V value of 0.91, demonstrating that the learning materials were scientifically accurate, relevant to the curriculum, and aligned with the specified learning objectives. This result indicates that the developed media provides appropriate conceptual content to support students' understanding of chemical reaction concepts while maintaining consistency with the current curriculum. The high content validity also reflects the successful integration of chemistry concepts with Guided Discovery Learning activities that encourage students to discover scientific concepts independently through structured exploration. Similar findings were reported by Lestari and Yerimadesi (2021), who concluded that Guided Discovery Learning-based learning materials effectively facilitate concept acquisition while maintaining curriculum relevance.

Although the display component received the lowest validity score among the assessed aspects (Aiken's V = 0.87), it still met the criteria for a valid instructional medium. The relatively lower score suggests that several visual elements, such as layout consistency, color composition, font readability, image quality, animation synchronization, or multimedia organization, could still be further refined to optimize users' visual experience. Nevertheless, the experts agreed that the visual design successfully integrated text, images, animations, videos, and audio to support chemistry learning. The incorporation of multiple representations enables students to visualize chemical phenomena at the macroscopic, submicroscopic, and symbolic levels, thereby facilitating a deeper understanding of abstract chemistry concepts. This finding supports the Cognitive Theory of Multimedia Learning proposed by Mayer (2021), which states that meaningful learning is enhanced when verbal information is effectively integrated with relevant visual representations. Likewise, Mutiarasani et al. (2025) demonstrated that interactive multimedia integrating multiple chemical representations significantly improves students' conceptual understanding of chemistry.

Overall, the expert validation results indicate that the developed interactive learning media possesses high validity across all assessed aspects. The consistently high Aiken's V values demonstrate that the media is suitable for classroom implementation and provides a strong foundation for improving students' conceptual understanding through Guided Discovery Learning.

Practicality assessment

To evaluate the practicality of the developed interactive learning media, a practicality assessment was carried out involving two chemistry teachers and 32 phase E students from SMAN 2 Bukittinggi. After using the media during classroom learning, both teachers and students completed practicality questionnaires to evaluate its ease of use, feasibility, and overall usefulness in supporting the learning process.

a.) Teacher practicality assessment

The practicality of the developed interactive learning media was evaluated based on teachers' responses after the media had been implemented in classroom instruction. The evaluation results showed an average practicality score of 96%, which falls into the very practical category. These findings indicate that the media is easy to use and can be effectively implemented to support chemistry learning. The complete results of the teacher practicality evaluation are presented in Table 2. To provide a clearer comparison of the practicality scores for each assessed aspect, the results are also presented in graphical form in Figure 7.

Table 4. Recapitulation of The teacher practicality assessment results of the interactive learning media

No	Assessed Aspect	Score (%)	Practicality Category
1	Ease of Use	95%	Very Practical
2	Learning Time Efficiency	100%	Very Practical
3	Benefit	94%	Very Practical
Overall average		96%	Very Practical

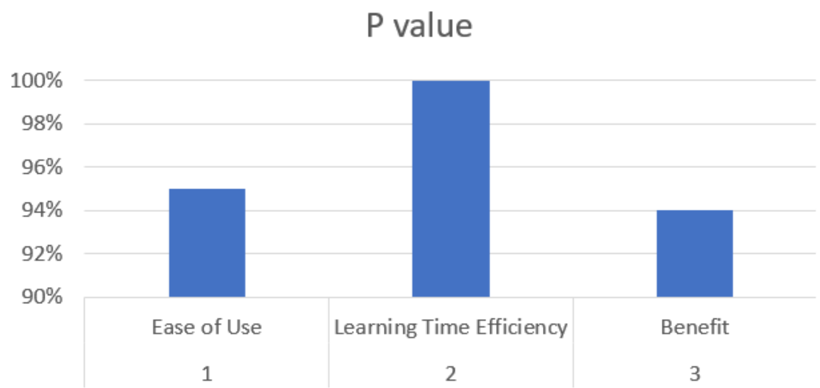

Figure 7. Graph of Teachers' Practicality Assessment Results

The teachers' evaluation indicated that the developed interactive learning media was highly practical for classroom implementation. The ease of use aspect obtained a score of 95%, demonstrating that the media was user-friendly and could be integrated effectively into chemistry instruction. The combination of multimedia elements, including text, images, audio, videos, and animations, contributed to increased student engagement and supported a better understanding of chemical reaction concepts (Hanatan et al., 2023). The time efficiency aspect received the highest score (100%), indicating that the media enabled teachers to conduct learning activities more efficiently. Meanwhile, the benefit aspect achieved a score of 94%, suggesting that the media provided meaningful support for both teaching activities and students' learning experiences. These findings are consistent with those reported by Yani and Yerimadesi (2023), who concluded that Guided Discovery Learning-based chemistry learning media exhibited a high level of practicality and effectively enhanced the teaching and learning process.

b.) Student Practicality Assessment

The practicality of the developed interactive learning media was further evaluated based on students' responses after its implementation in classroom learning. The results showed an average practicality score of 93%, indicating that the media falls into the very practical category. This finding reflects students' positive perceptions of the media in terms of its ease of use, usefulness, and effectiveness in supporting the learning process. The detailed results of the student practicality assessment are presented in Table 3, while a graphical representation of the assessment results is shown in Figure 8.

Table 5. Summary of Student Practicality Assessment Results of the Interactive Learning Media

No	Assessed Aspect	Score (%)	Practicality Category
1	Ease of Use	93%	Very Practical
2	Learning Time Efficiency	94%	Very Practical
3	Benefit	93%	Very Practical
	Overall average	93%	Very Practical

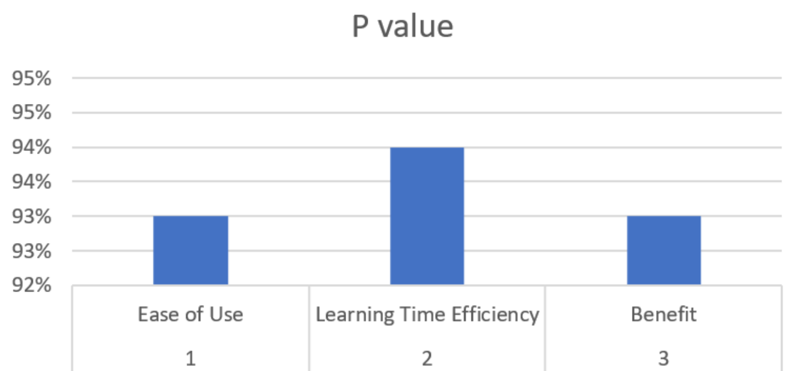

Figure 7. Graph of Teachers' Practicality Assessment Results

The interactive learning media was perceived by students as user-friendly and easily accessible throughout the learning process. The highest score was obtained in the time-efficiency aspect (94%), indicating that the media enabled students to complete learning activities more quickly and effectively. In addition, the benefit aspect reached 93%, demonstrating that the media meaningfully supported students in understanding chemical reaction concepts and enriched their overall learning experience.

These findings are consistent with previous studies reporting that interactive multimedia can enhance students' interest, participation, engagement, motivation, and conceptual understanding by providing more meaningful, interactive, and student-centered learning experiences. Moreover, digital learning media have been shown to facilitate conceptual understanding while fostering more engaging and effective learning environments (Chandra et al., 2023; Mayer, 2021). Overall, from the students' perspective, the developed media can be categorized as highly beneficial for learning.

Conclusion

Based on the findings, it can be concluded that the interactive learning media based on Guided Discovery Learning for chemical reaction topics in Phase E senior high school, developed using the 4-D model (limited to the develop stage), demonstrates a high level of validity with an Aiken's V value of 0.92 and a very high level of practicality, with scores of 96% from teachers and 93% from students. These results indicate that the developed media is valid, highly practical, user-friendly, and appropriate to be used as an alternative learning resource to enhance students' engagement and conceptual understanding in chemistry. However, this study has several limitations. The development process was only conducted up to the develop phase without proceeding to the disseminate stage. In addition, the practicality testing involved a relatively limited sample of 32 students, which may restrict the generalizability of the findings. Therefore, future research is recommended to continue the development process to the disseminate stage and to conduct large-scale implementation studies. Further studies are also suggested to investigate the effectiveness of the media on students' learning outcomes, conceptual understanding, and critical thinking skills.

In terms of practical implications, this media can be utilized by chemistry teachers as an innovative technology-based learning resource to support student-centered learning. It also provides insight for curriculum developers regarding the integration of Guided Discovery Learning and interactive multimedia in instructional design, and it may serve as a reference for policymakers in strengthening the implementation of digital learning media in senior high school chemistry education.

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