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Interactive Multimedia as An Innovative Strategy to Train HOTS in Reaction Rate Material: A Need Analysis

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Abstract: 21st-century education demands the development of higher-order thinking skills (HOTS) in students through contextual, collaborative, and technology-based learning. The material on reaction rates in chemistry is often challenging for students due to its abstract and complex nature, thus requiring innovative learning media to support conceptual understanding and HOTS development. This study aims to analyze the need for interactive multimedia development on reaction rate material to foster HOTS in 11th-grade high school students, focusing on students, teachers, media, facilities, and curriculum integration. The research method used is descriptive qualitative, involving questionnaires, interviews, and observations of 100 students and 1 chemistry teacher at SMA N 2 Sungai Selan. The results showed that students' need for interactive multimedia reached 92.79% (very needed category), especially to understand abstract concepts and increase learning motivation. Teachers' need for HOTS-based learning media reached 80.00% (very needed category), with existing potential that still requires improvement in its implementation. Students' readiness to use digital devices and the availability of school facilities support the development of interactive media. Based on these findings, developing HOTS-based interactive multimedia on reaction rate material is essential to enhance students' conceptual understanding, active involvement, and high-level thinking skills.

Keywords: Interactive Multimedia, HOTS, Reaction Rate

INTRODUCTION

21st-century education is an era of openness marked by the rapid development of science and technology. This transformation requires the education system to evolve, with learning that is more contextual, collaborative, and technology-based, enabling students to become adaptable, creative, and globally competitive (Randitha et al., 2025). Modern learning emphasizes the development of student skills, including critical thinking, creativity, collaboration, and digital literacy, which are central to 21st-century competencies (Nawawi et al., 2024). The Fourth Industrial Revolution further reinforces the need for higher-order thinking skills (HOTS), encompassing the abilities to analyze, evaluate, and create. The Merdeka Curriculum encourages the application of HOTS in the learning process, emphasizing

student-centered learning, fostering creativity, problem-solving skills, and active engagement in knowledge construction (Hidayat et al., 2025).

International assessments show that Indonesian students' thinking skills remain relatively low, particularly in solving problems that require analysis, evaluation, and creative solutions (Hartono et al., 2022). This condition affects chemistry learning, where students often struggle to understand concepts, analyze data, and solve problems demanding higher-order thinking. One topic that frequently challenges students is reaction rates, which are both abstract and applied in nature. This topic requires deep conceptual understanding, the ability to connect theory with real-world phenomena, and critical and analytical thinking skills (Naufal et al., 2021). The complex nature of reaction rate often leads to misconceptions and learning difficulties, causing many students to memorize formulas without truly understanding the underlying mechanisms (Mangara et al., 2024).

Furthermore, field learning practices indicate that teachers' use of effective learning media supporting HOTS remains limited (Salsabila et al., 2025). Many teachers still rely on conventional methods and less interactive media, resulting in suboptimal student engagement in critical, creative, and analytical thinking. This lack of appropriate media use contributes to students' low higher-order thinking skills, especially in abstract and complex material (Meike et al., 2024).

The use of innovative learning media can be a solution to these challenges. Interactive multimedia is a promising, innovative strategy because it combines text, images, animation, audio, video, graphics, and simulations in a single platform, enabling students to actively interact with the material (Arman et al., 2022). This media not only presents information but also encourages students to explore concepts, analyze phenomena, and solve problems independently (Fiani et al., 2024). Thus, interactive multimedia-based learning can enhance in-depth understanding of concepts while simultaneously training higher-order thinking skills (HOTS), enabling students to develop the critical, creative, and analytical abilities needed to face the challenges of the 21st century.

Nevertheless, the implementation of interactive multimedia in school chemistry education remains limited. Teachers often use media merely as a presentation aid without fully integrating it into HOTS development (Salsabila et al., 2025). Additionally, students' readiness to use technology and the availability of supporting facilities, such as digital devices and computer laboratories, are crucial factors determining the success of interactive media implementation (Heriyanto & Handri, 2025). Therefore, a comprehensive needs analysis is required, covering teacher readiness, student interests and abilities, media and facility availability, and curriculum alignment, to ensure that the development of HOTS-based interactive multimedia can be carried out effectively, relevantly, and in a manner that enhances students' higher-order thinking skills.

Based on this background, this study aims to analyze the needs for developing interactive multimedia on reaction rate material to cultivate HOTS in 11th-grade high school students, focusing on the needs of students, teachers, learning media, facilities, and curriculum integration. The results of this analysis are expected to provide a strong foundation for designing innovative, interactive learning media that effectively support the development of higherorder thinking skills.

METHOD

The research method used in this needs analysis is descriptive qualitative. This method aims to provide a deep understanding of the needs of students, teachers, learning, and learning media in the form of interactive multimedia at SMA N 2 Sungai Selan. The subjects in this study were students of grade XI Science and Chemistry teachers. The sample in this study was 100 students and 1 Chemistry teacher. The data analysis technique used was triangulation. The goal was to test the consistency and validity of the data by comparing information obtained from various sources or methods. Data collection techniques used in this study were

questionnaires, interviews, and observations in the form of documents and photos. The questionnaire aimed to determine the percentage of students' and teachers' needs concerning the development of interactive multimedia for teaching reaction rates in chemistry. Interviews were conducted with chemistry teachers to find out more about chemistry learning, media use, facilities and infrastructure, learning facilities, and the learning process. Observations included photos and documents to be analyzed regarding the curriculum, learning, facilities, and infrastructure, and the use of technology in schools.

The needs analysis questionnaire for students was administered to Grade XI students. The following is the blueprint (grid) of the student needs analysis questionnaire used in this study (Fatimah et al., 2021).

Table Student needs analysis questionnaire grid

No.	Aspect	Indicator Observed	Item Number
1	Students' Difficulties in Reaction Rate Material	Ease of understanding the material through the use of learning media	1, 2
		Level of difficulty in understanding scientific concepts, particularly in reaction rate material	3
		Level of interest in actively participating in science learning	4, 5
2	Availability of Supporting Facilities and Media	Ownership of devices such as smartphones, laptops, or gadgets that can be used for learning	6, 7
		Knowledge about learning media, especially interactive multimedia	8, 9
		Availability of learning facilities such as computer laboratories within the school environment	10
		Use of interactive and engaging learning media by teachers	11
3	Need for Learning Media	Development of interactive and engaging learning media by teachers	12
		Utilization of smartphones, laptops, or gadgets by teachers as learning media	13
		Students' interest in using interactive multimedia in Chemistry learning	14
		Students' interest in integrating interactive multimedia into reaction rate material	15

The teacher needs analysis questionnaire was administered to the Chemistry teacher. The following is the blueprint (grid) of the teacher needs analysis questionnaire used in this study (Atikasari & Desstya, 2022).

Table Teacher needs analysis questionnaire grid

No.	Aspect	Indicator Observed	Item Number
1	Use of Learning Media	Use of learning media by the teacher in teaching reaction rate material	1, 2
2	Problems Encountered in Using Learning Media	Obstacles faced by the teacher in using learning media	3, 4, 5
		Facilities and infrastructure supporting the learning process	6, 7
3	Potential Supporting the Development of Learning Media	Teacher's knowledge of interactive multimedia	8, 9, 10, 11
		Teacher's knowledge of HOTS (Higher Order Thinking Skills)	12, 13, 14, 15
4	Need for Learning Media to Teach Reaction Rate Material	The necessity of developing interactive multimedia	16, 17, 18

The data obtained from the questionnaire were analyzed using descriptive quantitative analysis by calculating the percentage distribution of each response option. These percentages were then interpreted to determine the level of need and readiness for the development of the intended learning media. The percentage calculation was performed using the formula proposed by Bakri et al. (2015).

$$\text{Pecentage}(\%)=\frac{\sum skor\ Perolehan}{\sum skor\ maksimum}\ \text{X}\ 100\%$$

Table Categories of Needs (Lian dkk., 2021)

Average (%)	Category
76%–100%	Very Needed
57%–75%	Needed
26%–60%	Less Needed
0%–25%	Not Needed

Below is the blueprint of the interview guide administered to the Chemistry teacher, which was used in this study to obtain an in-depth understanding of learning media, student characteristics, curriculum analysis, and the required resources (Azzahra et al. 2025).

Table Teacher interview Grid

No.	Aspect	Indicator
1	Learning Media	Availability of learning media
		Frequency of learning media use
		Problems related to learning media
		Expectations for learning media development
2	Student Characteristics	Number of students
		Students' learning interest
3	Curriculum Analysis	Curriculum implemented
		Learning models and methods frequently applied
		Problems related to curriculum implementation
4	Required Resources	Use of technology in schools
		Facilities supporting the learning process

Observation was used to support the research data obtained from the student needs analysis questionnaire and the teacher needs analysis questionnaire. The indicators in the observation were aligned with those used in the student and teacher needs analysis questionnaires. The observation was also supported by various documents related to school facilities and infrastructure, such as LCD projectors, computer laboratories, and adequate network connections. In addition, lesson plans (RPP) or teaching modules were examined to analyze the curriculum, learning models, and teaching methods. The use of technology was also observed to assess how technology is utilized in Chemistry learning.

RESULTS AND DISCUSSION

The research results comprise findings from the student needs analysis questionnaire, the teacher needs analysis questionnaire, interview results, and observation results.

Tthe Student Needs Analysis

The data for the student needs analysis were obtained through the distribution of questionnaires using Google Forms to the students. The results of the questionnaire analysis are presented in the following figure.

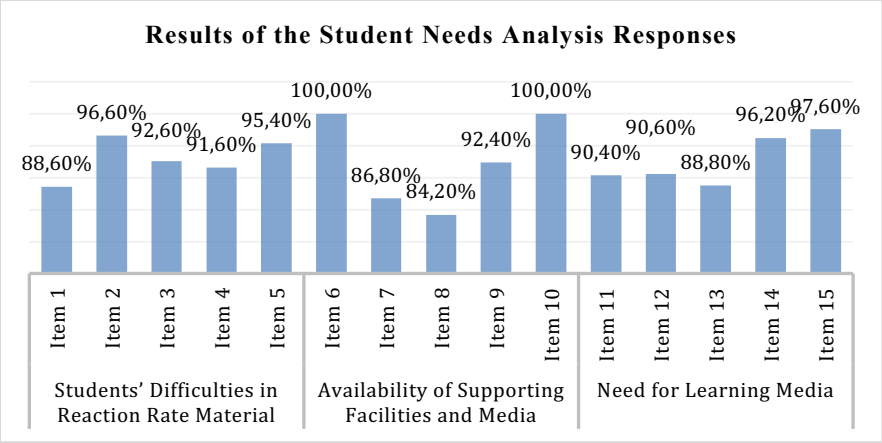

Figure Results of the Student Needs Analysis Responses

The results of the data analysis on the aspect of students' difficulties in reaction rate material show that 88.60% of students still experience challenges in learning Chemistry, particularly in the topic of reaction rate. Meanwhile, 96.60% of students stated that learning media could help them better understand the material. In addition, 92.60% of students agreed that visual or animation-based media assist them in comprehending abstract concepts, especially in the topic of reaction rate. This indicates that visual approaches can effectively bridge the gap between abstract chemical concepts and students' understanding. Furthermore, 91.60% of students expressed interest in being active during the learning process, and 95.40% reported feeling more enthusiastic when learning through instructional media.

The analysis results on the availability of facilities and learning media to support the learning process indicate that 100% of students have access to smartphones, laptops, or other devices that can enhance their learning activities. As many as 86.80% of students are already accustomed to using their personal devices to support learning, demonstrating their readiness to utilize technology independently. Additionally, 84.20% of students are already familiar with interactive multimedia as a form of learning media, and 92.00% have previously used interactive learning media in their studies of science or chemistry. This indicates that most students have prior experience with technology-based learning media. From the perspective of school facilities, 100% of students stated that the school provides adequate learning infrastructure, including a computer laboratory, which supports the integration of technology into the learning process.

The results of the learning media need aspect indicate that most teachers have utilised interactive learning media in Chemistry lessons. This is reflected in the fact that 90.40% of students stated that teachers have used interactive and engaging media during the learning process, and 90.60% reported that teachers have even created such materials themselves. Furthermore, 88.80% of respondents mentioned that teachers have maximised the use of smartphones, laptops, or other gadgets as learning media, indicating the integration of technology to enhance learning. In terms of students' interest, 96.20% expressed enthusiasm for using interactive multimedia as a learning medium, and 97.60% specifically stated their interest in using interactive multimedia integrated with the topic of reaction rate.

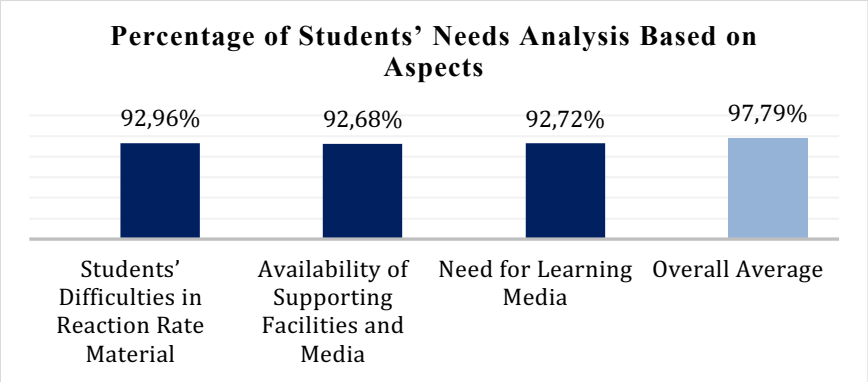

Figure Percentage of Students' Needs Analysis Based on Aspects

The aspect of students' difficulties in reaction rate material shows a percentage of 92.96%, classified as a very need. This indicates that most students struggle to understand abstract concepts, as some are unable to visualize chemical reactions concretely through verbal or textual explanations alone. Visual-based interactive learning media can significantly help students grasp these abstract concepts, making learning more tangible and easier to understand. Observations support this finding, showing that teachers have integrated various interactive multimedia, such as instructional videos, PowerPoint presentations, and digital platforms like Kahoot and Quizizz, to evaluate student understanding in an engaging way. Teachers have also prepared lesson plans and teaching modules containing learning objectives, activities, and HOTS-based assessments, enabling students to participate actively in the learning process. These findings align with research by Roslina et al. (2025), which states that interactive multimedia can enhance the understanding of abstract concepts and improve student engagement in chemistry. Additionally, Salma'a et al. (2024) emphasize that visual and interactive media effectively aid students in comprehending complex concepts while increasing learning motivation. Thus, the students' difficulties indicate a strong need for the development of interactive learning media to reduce learning barriers and enhance engagement.

The aspect of facility and learning media availability shows a percentage of 92.68%, also classified as a very nedeed. The analysis indicates that students are well-prepared to support technology-based learning. Almost all students possess personal devices, such as smartphones or laptops, and are accustomed to using them for learning both in school and at home. Most are familiar with and have experience using interactive multimedia, especially in science and chemistry. School facilities, including computer labs and internet access, are adequate to support digital learning. This demonstrates strong readiness, both individually and institutionally, for the development of HOTS-based interactive multimedia. Observations indicate that teachers effectively utilize these facilities to facilitate an understanding of abstract concepts and enhance student participation. These findings are consistent with Wahyudi & Fauziati (2025), who state that facility availability and students' digital skills are key factors for successful implementation of multimedia-based learning, and Rizki et al. (2024), who confirm that optimal use of digital devices enhances engagement and helps students understand abstract concepts through interactive visualization. Therefore, facility readiness and students' technological experience provide a strong foundation for developing and implementing HOTS-based interactive learning media in reaction rate material.

The aspect of learning media needs shows a percentage of 92.72%, categorized as a very needed. Survey results indicate that teachers have utilized interactive learning media in chemistry, and some even create their own media to clarify concepts. This demonstrates teachers' efforts to provide innovative, technology-relevant learning. Teachers' use of devices such as smartphones and laptops reflects awareness of the importance of integrating technology in teaching. Students show high interest in interactive multimedia, finding it engaging, easy to

understand, and helpful in mastering chemistry concepts. Survey results show that nearly all students have a strong interest in using interactive multimedia for learning chemistry. They consider interactive media to make learning more engaging, understandable, and supportive of conceptual mastery. Interest is especially high when interactive multimedia is integrated with reaction rate material. These findings align with those of Nadia et al. (2025), who show that interactive multimedia in chemistry learning can increase motivation and understanding, particularly for abstract material. Additionally, Rahmani & Hikmawan (2025) confirm that digital interactive media helps students develop a deeper conceptual understanding while training critical and analytical thinking skills. Therefore, the demand for interactive learning media in chemistry is extremely high. Teachers have demonstrated a willingness to integrate technology into learning, and students have shown a strong interest in contextual and interactive media. Therefore, developing interactive multimedia for reaction rate material is highly relevant to meet learning needs.

Based on the overall analysis of students' needs, the average score is 92.79%, categorized as a very need. This is evident across three main aspects that support each other. Most students still struggle to understand abstract concepts in reaction rate material. Therefore, the development of multimedia-based interactive learning media is necessary to help students visualize chemical reactions in a concrete and engaging way. Both students and the school are highly prepared to support technology-based learning. Almost all students have access to digital devices and are accustomed to using them for educational purposes. School facilities such as computer labs and internet access are sufficient to support interactive learning. This provides a strong foundation for developing learning media. Teachers have utilized technology in chemistry teaching and strive to create engaging and interactive media. Students demonstrate a high need for interactive multimedia, particularly in reaction rate materials, as it makes learning more engaging, easier to understand, and increases active participation. These findings align with Sari et al. (2025), which shows that developing interactive multimedia in chemistry effectively improves students' higher-order thinking skills by presenting abstract phenomena visually in an understandable way. Therefore, it can be concluded that the development of multimedia-based interactive learning media is essential for training students' HOTS in reaction rate material.

The Teacher Needs Analysis

The data for the teacher needs analysis were obtained through the distribution of questionnaires via Google Forms and interviews with the Chemistry teacher. The results of the questionnaire analysis are presented in the following table.

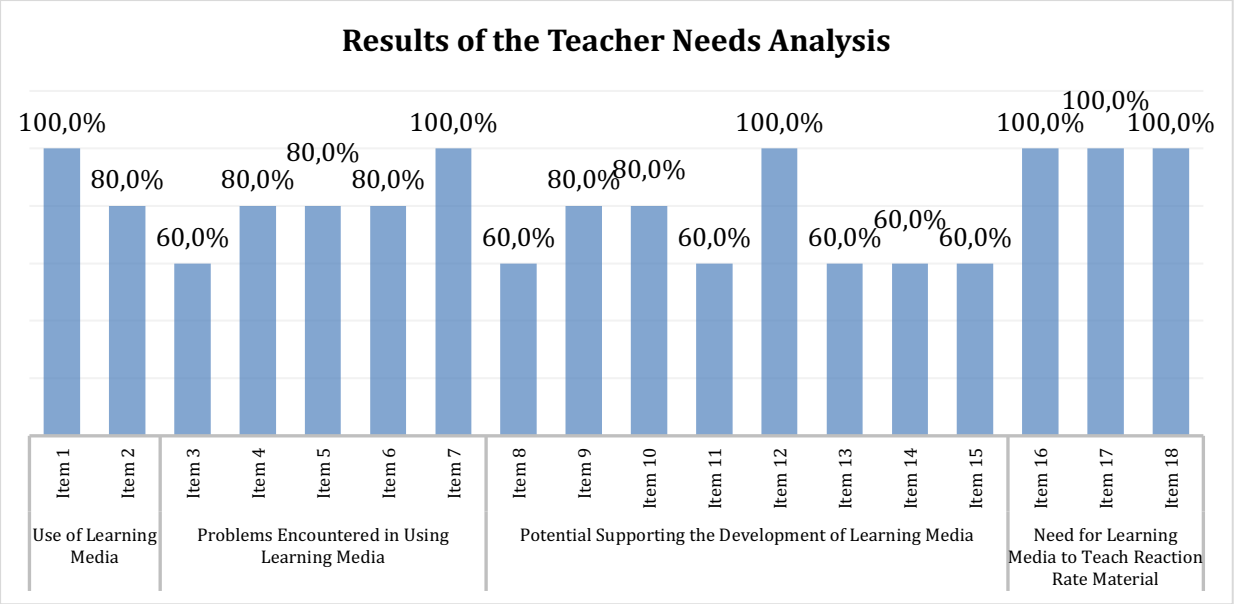

Figure Results of the Teacher Needs Analysis

The results of the teacher's use of learning media show that 100% of teachers have used learning media in Chemistry learning activities. However, when examined more specifically in relation to the reaction rate topic, the percentage of teachers who have applied learning media decreased to 80.00%.

Regarding problems encountered in using learning media, 60% of teachers reported that they still experience obstacles in their use. Nevertheless, the majority of teachers 80% stated that they often use learning media in teaching activities and even create their own learning media to support the learning process in class. Furthermore, 80% of teachers considered that the available facilities and infrastructure sufficiently support the use of media in the teaching and learning process. Additionally, 100% of teachers confirmed that school facilities, such as LCD projectors, computer laboratories, and internet networks, already support the utilization of interactive multimedia in learning.

Based on the results of the teacher needs analysis regarding the potential for supporting the development of learning media, it was found that teachers possess knowledge of interactive multimedia at 60%, and 80% have used interactive multimedia in the learning process. Teachers also stated that the use of interactive multimedia is necessary for teaching the reaction rate topic, with a score of 80%. However, only 60% of the media used were considered appropriate for delivering reaction rate material. Furthermore, teachers demonstrated complete understanding of the HOTS (Higher Order Thinking Skills) concept 100% and assessed that 60% of the learning media used were HOTS-based. However, only 60% of teachers had measured students' HOTS, and the same percentage 60% believed that the learning media used had a significant effect on improving students' HOTS.

In the aspect of the need for learning media to teach reaction rate material, the data show that teachers gave a complete 100% positive response to all three statements presented. Teachers considered it highly necessary to develop learning media in the form of interactive multimedia that can train students' higher-order thinking skills (HOTS). Additionally, teachers noted that interactive multimedia is expected to help students better understand the abstract concept of reaction rates and assist them in developing higher-order thinking skills through practice questions, simulations, and exploration-based activities.

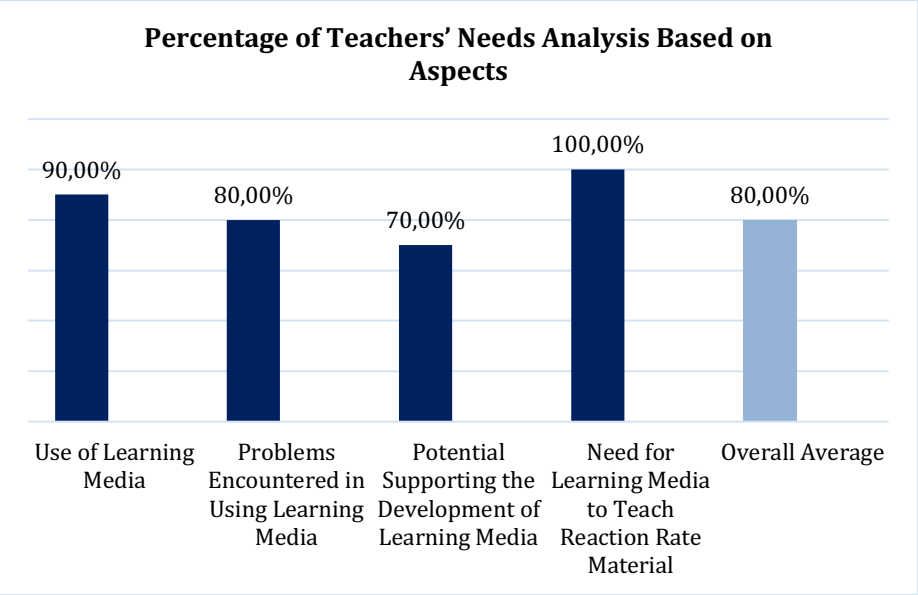

Figure Percentage of Teachers' Needs Analysis Based on Aspects

The aspect of learning media usage scored 90% in the very needed category. This suggests that teachers typically incorporate media into chemistry instruction, reflecting their awareness and efforts to create a more engaging and interactive learning experience. However, when specifically considering reaction rate material, the use of learning media decreases. Although teachers routinely use media, there is still a need to enhance its application, particularly for complex topics such as reaction rates, to help students better understand abstract concepts and actively participate in learning. One teacher explained, *"So far we have been using existing learning media such as PowerPoint and educational videos from YouTube; there is no interactive media created by ourselves in chemistry learning,"* and added, *"I myself, as a teacher, use learning media such as PowerPoint or educational videos in almost every lesson."* This indicates that technology-based media are routinely used, although they remain largely passive and have not been independently developed. The teacher also mentioned efforts to vary media to prevent student boredom, *"I have created quizzes several times using Kahoot or Quizizz so that students do not get bored and can learn while playing."* Observations confirmed that PowerPoint presentations, educational videos, and interactive quizzes such as Kahoot and Quizizz are integral to classroom activities. Previous studies support this, showing that interactive learning media effectively improve students' conceptual understanding and learning motivation (Roslina et al., 2025).

The aspect of available facilities and supporting media scored 80% in the very needed category. The analysis reveals that the school offers adequate facilities and learning support materials, although teachers continue to face challenges in utilizing them. Teachers routinely use media and have even created their own to enhance classroom learning. They also assess that existing facilities are sufficient to support teaching and learning activities. School facilities, including LCD projectors, computer laboratories, and internet access, are available and adequate to support interactive multimedia. One teacher stated, "The use of technology in the school has been applied well. In my teaching, I typically use school facilities, including LCD projectors and other equipment. Students are also allowed to bring their phones to support learning. The computer lab exists, but its use during lessons is very rare because it requires an operator." Observations and documentation confirm that digital learning resources are sufficiently available, although not all are fully utilized in chemistry activities. Teachers primarily use projectors and students' phones, while the computer laboratory is rarely used due to technical issues and limited operator availability. This finding aligns with Nelliraharti and Jarmita (2025), who emphasize that adequate learning facilities can improve students'

motivation and learning quality. Accessible and complete facilities enable students to learn effectively, highlighting the need to support optimal use of learning media.

The analysis also shows that the need for learning media is 70.00% in the needed category, indicating that teachers understand and have implemented interactive multimedia, although not optimally. Teachers recognize the importance of interactive media for reaction rate material, yet its use remains as a supporting tool and is not fully integrated with Higher Order Thinking Skills (HOTS). A teacher stated, "I know HOTS, which involves analyzing, evaluating, and creating according to Bloom's taxonomy. I use HOTS myself in preparing questions," and added, "I have never developed my own learning media due to time constraints, so I use what is available online, except for quizzes; I have created quizzes several times using Kahoot or Quizizz so students don't get bored and can learn while playing," and "Although media fully integrated with HOTS is not yet available, I use educational videos to support HOTS, so students can analyze from the videos." This demonstrates that teachers have implemented HOTS through interactive quizzes and video analysis. Observations also show that teachers apply active learning models such as Discovery Learning, Problem-Based Learning (PBL), and Project-Based Learning (PJBL), and include HOTS-based questions in lesson plans and teaching modules. However, media use is still limited to information delivery and does not fully encourage independent analysis, reasoning, and problem-solving. This aligns with previous research by W.P. Putra et al. (2023), which states that interactive multimedia can stimulate higher-order thinking skills in students. Ridho'i and Fauzi (2025) emphasize that HOTS-based interactive multimedia can enhance critical thinking and problem-solving skills. Teachers, therefore, have strong potential and readiness for implementing HOTS-based interactive multimedia, yet more innovative media development is needed to optimize the stimulation of higher-order thinking skills in chemistry, particularly for reaction rate materials.

Regarding teachers' expectations for media development, a score of 100% was obtained in the very needed category, indicating full support for developing interactive multimedia in chemistry learning. Teachers consider interactive media essential for helping students understand abstract concepts, such as reaction rates, more easily, and they hope it can also foster students' higher-order thinking skills. One teacher explained, "I am very happy that research is being conducted in the school, as it adds to my teaching resources," and added, "I am interested here because it includes HOTS, so it can train students' thinking skills." This shows that teachers expect interactive media to be not only visually appealing but also capable of fostering critical, analytical, and collaborative thinking. Observations confirm that teachers apply active learning models such as PBL, PJBL, and Discovery Learning, and include HOTS-based questions in teaching modules. This aligns with research by Prayogi and Prasetyo (2025), which demonstrates that interactive media can enhance students' motivation and participation in chemistry learning. Additionally, research by Meike Paat et al. (2024) emphasizes the role of HOTS-based interactive multimedia in developing higher-order thinking skills. Developed media is expected not only to function as a visualization tool but also as an active and collaborative learning platform that fosters enthusiasm, motivation, and higher-order thinking skills.

Overall, the average need for learning media is 80% in the very needed category. Almost all aspects fall into the very needed category, showing that teachers consider learning media, particularly interactive multimedia, crucial for student understanding. However, the potential to support media development is only 72.50% in the needed category. This indicates that although teachers recognize the importance of learning media, the media used so far have not been fully aimed at developing students' HOTS. In other words, the potential for implementing HOTS through media is still limited, requiring the creation of media specifically designed to encourage students to analyze, evaluate, and create in the context of reaction rate material. Therefore, the development of HOTS-based interactive multimedia is essential to maximize this potential in the learning process.

CONCLUSION

Based on the results of research on the needs analysis for developing interactive multimedia on reaction rate material to train Higher Order Thinking Skills (HOTS) of eleventh grade high school students it was found that the average student need reached 92.79% in the very needed category while the average teacher need was 80% in the very needed category The majority of students experienced difficulties in understanding abstract concepts in reaction rate material making visual and interactive learning media highly necessary to facilitate understanding increase motivation and encourage active engagement in the learning process Teachers in general have used learning media and understand the concept of HOTS as well as its application in the learning process using HOTS-oriented learning models however the implementation of specific media for reaction rate material still needs to be improved to be more innovative and effective in developing students higher-order thinking skills The readiness of students to utilize personal digital devices along with the availability of school facilities such as computer laboratories LCD projectors and internet networks provides a strong foundation for the development and implementation of HOTS-based interactive multimedia The school has implemented the Merdeka Curriculum Therefore the development of interactive multimedia for reaction rate material is highly needed and is expected to enhance the understanding of abstract concepts active student engagement and higher-order thinking skills optimally.

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