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Leveraging ChatGPT for Developing Learning Object Material: A Multi-representation Approach to Teaching Water Pollution

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Abstract

Teaching students about water pollution empowers them to make informed choices and contribute to a healthier, sustainable future. This research aims to explore the utilization of ChatGPT, in conjunction with Canva and Renderforest applications, to develop learning object material with a practical multi-representational approach. The objective is to create engaging and interactive educational content on water pollution, catering to diverse learning preferences and enhancing students' understanding of the subject. The research employed a mixed-methods research design, combining qualitative data from the developed learning object material with quantitative data gathered through a USE questionnaire. The research participants consisted of 23 seventh-grade students grouped into four teams who are engaged in a 30-minute group learning session with the learning object material. Following the group activity, a 10-minute question-and-answer session addressed any queries. Subsequently, students individually attempted test questions in multiple-choice, matching, and true/false formats. The results indicate positive student's responses to the learning object material, demonstrating its effectiveness in promoting water pollution awareness. Most students agree on the material's usefulness, ease of use, ease of learning, and satisfaction. The findings emphasize the potential of AI-driven content creation and its seamless integration with creative tools in transforming the educational landscape. The research recommends continued research and development in AI integration in education to enhance the application's performance, usability, and adaptability to cater to diverse learning needs and preferences. The positive impact of AI integration in education holds promise for fostering better understanding and promoting the transformation of traditional learning approaches into technology-driven.

Keywords: ChatGPT, Multi-representational approach, Renderforest, Student engagement, Water pollution

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INTRODUCTION

Education faces the challenge of accommodating the differences in students' characteristics during the learning process, including in the context of Science education (Zidny et al., 2020; Höttecke & Allchin, 2020). Each student possesses unique learning styles and preferences, necessitating diverse learning approaches to ensure effective access to the material for all students. However, within the constraints of a classroom environment, often with many students, creating personalized and individualized learning for each student becomes daunting (Taylor et al., 2021). When the variations in students' characteristics are not well accommodated, some students may feel neglected or need help to fully engage in the learning process.

Digital technology, particularly Artificial Intelligence (AI), has introduced new opportunities to address this issue. One solution offered by AI is its ability to create learning objects that can be tailored to each student's needs and learning preferences. With the assistance of AI, the learning approach can be customized based on each

student's characteristics and learning style (Sudibjo et al., 2019). AI can analyze data on students' learning behaviours, preferences, comprehension levels, and appropriate difficulty levels. Based on this information, AI can generate learning object material customized with the proper difficulty level, the most effective presentation style, and content relevant to each student's interests (Alam, 2021). Teachers can provide a more adaptive and inclusive learning experience by implementing AI technology in science education. Students will feel more engaged and supported in learning as the material is tailored to their needs. Thus, AI technology opens up new opportunities to enhance the quality of education, strengthen student participation, and ensure that each student has an equal opportunity to reach their full learning potential.

ChatGPT, one of this technology, offers educators and content creators many possibilities to design innovative and effective learning object material on environmental issues (Qadir, 2023; Dwivedi et al., 2023; Adiguzel et al., 2023). Its versatility, interactivity, and ability to adapt to individual learning needs make it invaluable in fostering environmental awareness and inspiring the next generation of environmentally-conscious individuals. ChatGPT, powered by the advanced GPT-3.5 language model, presents exciting possibilities for creating learning object material on environmental issues, mainly focusing on ecological and preservation topics. ChatGPT can generate human-like text as an AI language model, making it a valuable tool for educators and content creators seeking to develop engaging and informative materials for teaching about environmental concerns. ChatGPT can be utilized to design dynamic and interactive learning materials that allow students to engage with the content actively. With ChatGPT, educators can tailor learning materials to meet students' individual needs.

Water pollution is undeniably one of the crucial issues that students need to be well-informed about. Teaching students about water pollution is not only about informing them of a pressing issue but also about empowering them to make informed choices, become advocates for change, and contribute to a healthier and more sustainable future for themselves and the planet (Laurie et al., 2016; Mochizuki & Bryan, 2015). Therefore, this topic is included in the junior high school curriculum, especially in the 7th grade. At this stage, they have a mature understanding and can delve deeper into complex environmental issues. It allows them to understand the impacts more profoundly, including their effects on aquatic ecosystems and human life. Teaching pollution prevention and protection measures are essential at this level. Students learn concrete steps to safeguard water resources and prevent pollution (Boca & Saraçlı, 2019). Additionally, they begin to comprehend the role of government policies and actions in addressing water pollution, fostering an interest in environmental policy issues.

Environmental issues constantly evolve, and up-to-date information is crucial for comprehensive learning. ChatGPT can be programmed to access the latest data and research on ecological challenges, ensuring that the learning object material remains relevant and accurate. ChatGPT can be integrated with various media formats, such as images, videos, and graphs, enabling a multi-representation approach to environmental education (Zhang et al., 2023; Shen et al., 2023). This combination of text and visual aids enhances comprehension and retention, catering to diverse learning preferences. This interactive approach fosters critical thinking, problem-solving skills, and a deeper understanding of the complexities associated with environmental issues. ChatGPT can transform the learning experience into an enjoyable and motivating journey by incorporating gamification elements.

On the other hand, Canva excels in educational material development due to its user-friendly interface and a wide range of design templates, making it easy to create visually engaging and informative content for learners (Bondarenko et al., 2019; Salim et al., 2021). Numerous studies on instructional material development using Canva have

demonstrated the effectiveness of this application in producing high-quality learning media. The plug-and-play nature of Canva expedites educators in creating top-notch learning media for teaching (Megawati et al., 2021). Therefore, this research used Canva to create learning media on water pollution.

This research explores the utilization of ChatGPT, combined with Canva and Renderforest applications, in developing learning object material with a practical multi-representational approach. The integration of these technologies offers a dynamic and interactive learning experience that caters to diverse learning preferences, fostering better comprehension and retention of educational content. The study highlights the potential of AI-driven content creation and its seamless integration with creative tools. It presents a promising avenue for enhancing the educational landscape and promoting practical multi-representational learning experiences for students.

METHODS

This research had three crucial stages: the development of learning object material related to water pollution, the implementation of teaching, and the evaluation of learning outcomes. The flowchart in Figure 1 illustrated these stages.

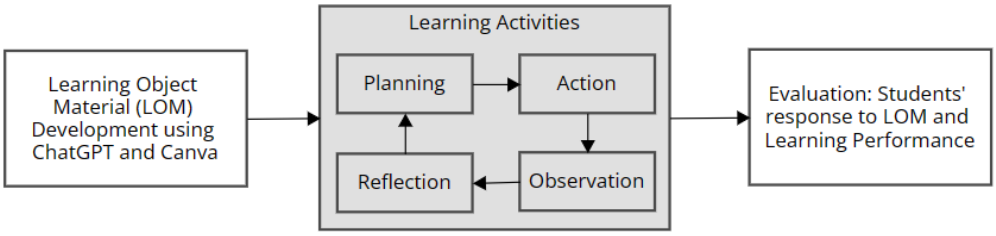


Figure 1. Flowchart of the Research Stages

This research employed a cyclical planning process, action, observation, and reflection to enhance the learning object material continuously. The participants in this research were 7th-grade students from a junior high school. The AI language model ChatGPT was utilized to generate the initial content for the learning object material on water pollution. The content derived from ChatGPT was then transformed into various formats, including videos, posters, and a book, catering to diverse learning preferences. The Canva platform was used to design posters and visual elements to enrich the learning experience. In contrast, the Renderforest platform was used to create engaging and informative videos concerning water pollution.

Multiple-choice, matching, and true/false questions were developed using ChatGPT to assess students' comprehension of the material, with each set of questions comprising five items. The USE Questionnaire served as an evaluation instrument designed to collect students' feedback on the usefulness of the learning object material. Subsequently, students were requested to complete the USE Questionnaire to provide their input on the learning material's efficacy.

Following the completion of the learning activities, a structured test was administered to assess the effectiveness of the learning object material. Quantitative data were analyzed using appropriate statistical methods to measure the impact of the learning object material on students' understanding. The learning outcomes from various evaluation questions were assessed using a minimum passing criterion of 75 out of 100. In this study, learning outcomes were only assessed at the end of the teaching process,

which has limitations in capturing the progression of students' understanding of the learning material.

The students' responses were gathered through a questionnaire known as the USE questionnaire, specifically designed to assess their overall experience and perception of the learning object material. The questionnaire employed a 5-point Likert scale, allowing participants to rate their agreement or disagreement with the provided statements. The scale ranged from 1 (Strongly Disagree/ SD) to 5 (Strongly Agree/ SA), with a neutral score of 3 excluded from the analysis. The 5-point Likert scale allowed for quantifying the student's attitudes and opinions towards the learning object material. The removal of the neutral score (3) from the analysis prevented respondents from adopting a neutral stance and compelled them to express either agreement or disagreement with the statements.

RESULTS & DISCUSSION

Results

The outcome of the product development process consists of videos, posters, and a book that elucidates the topic of water pollution. The materials used in this development are sourced from ChatGPT's responses to the question: "Beri contoh pencemaran air" (or Provide examples of water pollution). Figure 2 illustrates the question and ChatGPT's reaction.

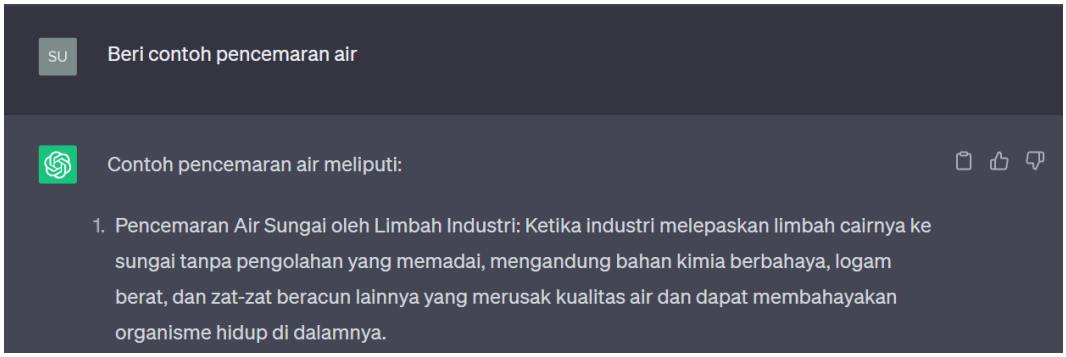


Figure 2. ChatGPT response to the question about water pollution

From the responses mentioned earlier (ChatGPT), learning object material is developed in various formats, including videos, posters, and a book. Figure 3 illustrates the process and its outcomes. The created video lasts 1 minute and 8 seconds, comprising seven distinct scenes. The poster consists of concise explanations accompanied by illustrations depicting water pollution phenomena. The book encompasses seven pages with more detailed descriptions for each example of water pollution. The book also features the same images as those presented in the poster.

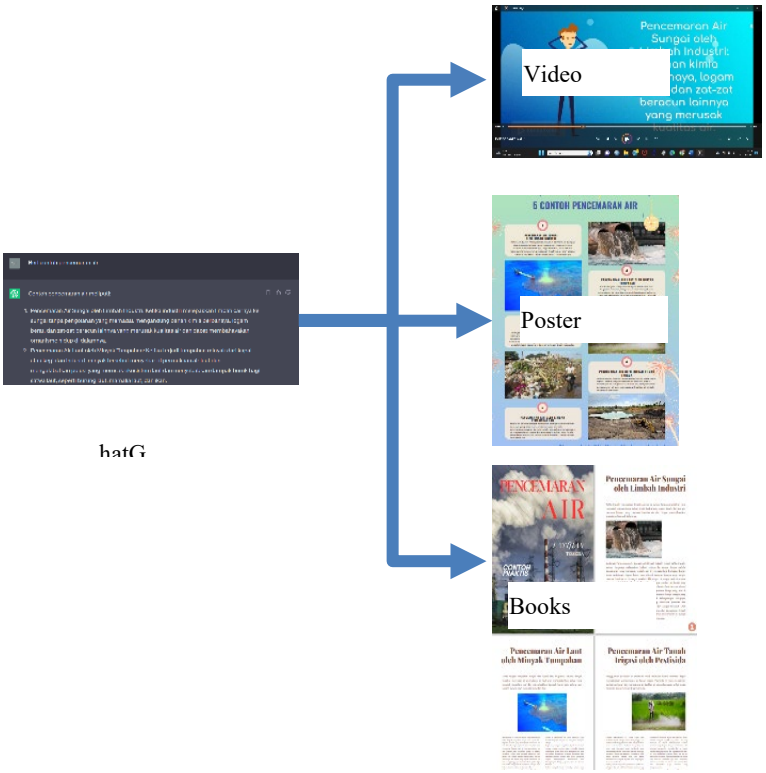


Figure 3. Learning Object Material in various formats (Video, Poster, and Books)

Figure 4 depicts the more detailed descriptions created with ChatGPT for the examples of water pollution. These outcomes provide explanations in the book that is being developed using Canva.

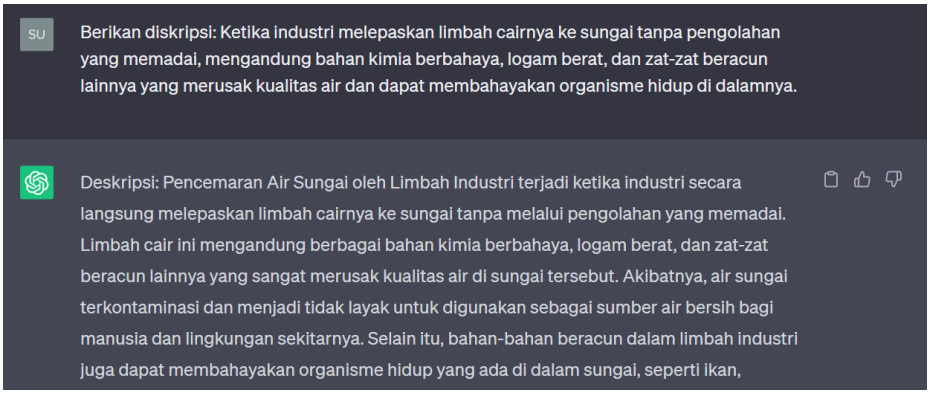


Figure 4. Detailed descriptions created with ChatGPT

Understanding related to the topic of water pollution is assessed through questions consisting of multiple-choice, matching, and true or false formats, each containing five items. These questions are formulated based on the content present in the learning object, utilizing ChatGPT. Figure 5 illustrates the results of this assessment instrument development.

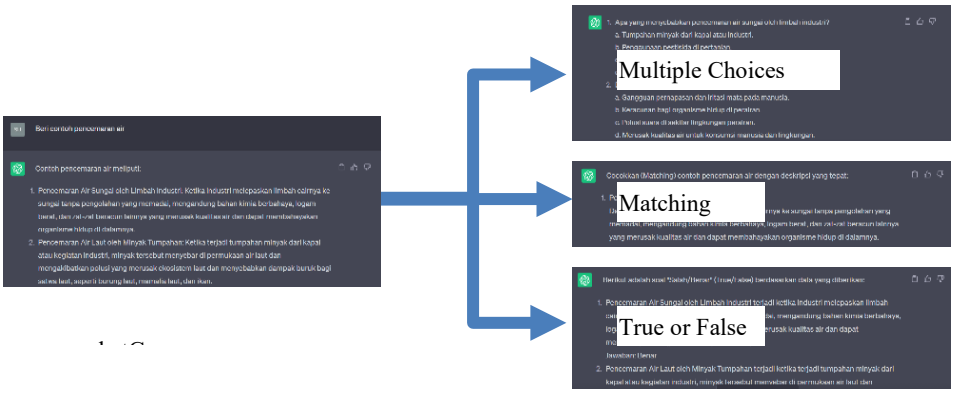
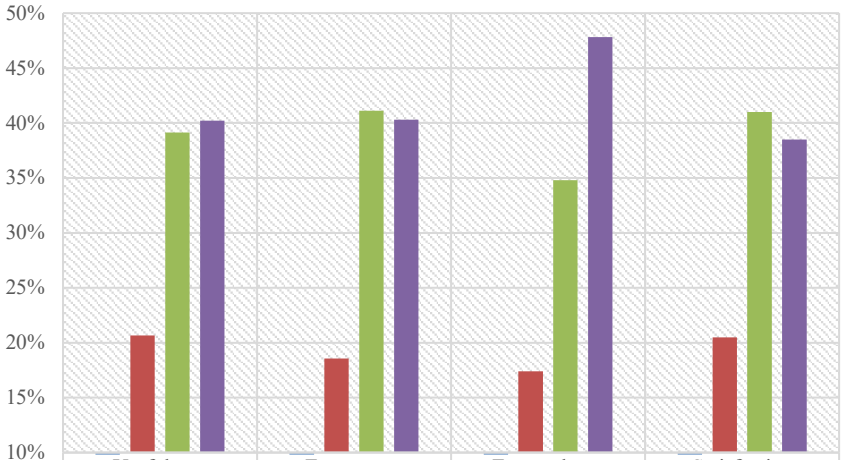


Figure 5. Detailed descriptions created with ChatGPT

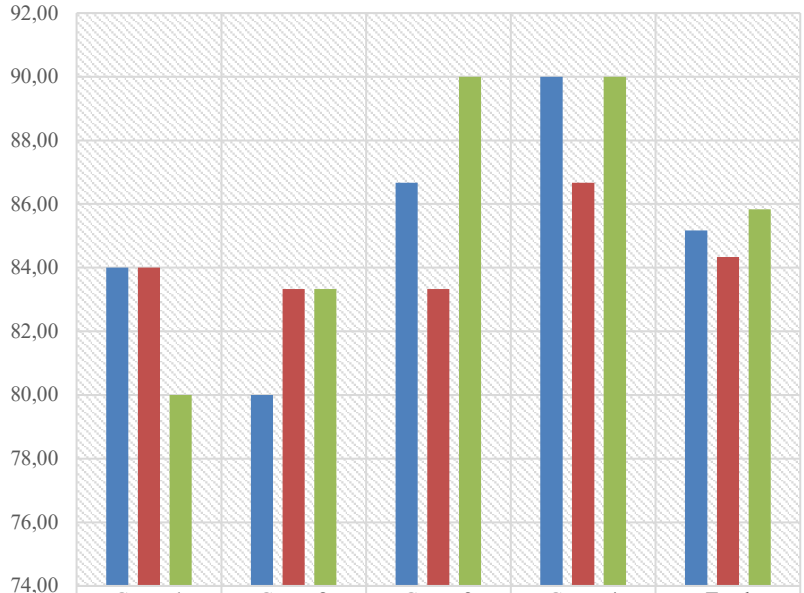
The data and analysis in this research offer an evaluation of an application utilized for science learning, specifically on water pollution. The application integrated various technologies, including ChatGPT and others. A questionnaire with four aspects, namely Usefulness, Ease of use, Ease of learning, and Satisfaction, was administered to measure user responses. The collected data is graphically represented in Figure 6.



	Usefulness	Easy to use	Easy to learn	Satisfaction
SA	0%	0%	0%	0%
A	21%	19%	17%	20%
D	39%	41%	35%	41%
SD	40%	40%	48%	39%

Figure 6. Student Response to the Learning Object Material

Twenty-three students participated in the learning session, divided into four groups, each consisting of 5 or 6 students. The learning occurs in groups, where each group received a complete set of learning object material, including a video, a poster, and a book. Every group is granted the freedom to conduct observations and discussions based on their interests using the provided learning materials. This activity is carried out within a 30-minute timeframe. Following the group activity, a 10-minute question-and-answer session addressed unclear terms or concepts. Afterwards, the students individually attempt the questions in three formats: multiple-choice, matching, and true/false. The scores for the tests are presented in Figure 7.



	Group 1	Group 2	Group 3	Group 4	Total
Multiple Choice	84,00	80,00	86,67	90,00	85,17
Matching	84,00	83,33	83,33	86,67	84,33
True/ False	80,00	83,33	90,00	90,00	85,83

Figure 7. Learning Performance Score

The learning assessment data indicates that all students meet the minimum passing criteria. In further research, it is essential to delve deeper into other factors contributing to this success.

Discussion

This research demonstrates that ChatGPT can create learning object material practically and effectively. In this case, ChatGPT is integrated with Renderforest and Canva technologies. The resulting learning objects consist of videos, posters, books, and test questions in multiple-choice, matching, and true/false formats. Integrating ChatGPT with these tools allow for the development of diverse and engaging educational materials. The findings of this research also align with the research conducted by other scholars, who have explored the various potentials of ChatGPT in education across different fields of knowledge (Gilson et al., 2023; Wardat et al., 2023; Kasneci et al., 2023). It is evident that ChatGPT's capabilities extend beyond this specific research and can be applied to enhance learning experiences in various disciplines. By leveraging AI technologies like ChatGPT, educators and content creators can efficiently produce customized learning materials to cater to the diverse needs of learners. The seamless integration of ChatGPT with other creative tools further streamlines the content development process, making it more accessible and feasible for educators to design interactive and immersive learning resources (Rathore, 2023). As the field of AI and education continues to evolve, ChatGPT and similar language models will likely play a prominent role in shaping the future of learning. The potential for innovative and personalized educational experiences through AI-driven learning object creation holds significant promise for transforming how knowledge is disseminated and absorbed in the educational landscape.

The data analysis results from the research provide valuable insights into the effectiveness of integrating ChatGPT and other applications in promoting water pollution

awareness and enhancing science education. The overwhelmingly positive reception from most students signifies the success of the AI-integrated learning media product. Students find the application to be useful, easy to use, easy to learn, and satisfying, highlighting its significance in their learning journey. The high level of agreement and strong agreement expressed by most students regarding the performance and benefits of the application reinforces its potential as an effective tool for science education. The positive feedback also suggests that integrating AI technologies like ChatGPT, Renderforest, and Canva in creating learning object material has resulted in engaging and interactive content that resonates well with students.

Moreover, the research findings are consistent with similar research in other fields, which demonstrate the potential of ChatGPT and AI's potential to promote critical thinking skills and foster better learning outcomes (Grassini, 2023; Lin, 2023; Santos, 2023). It indicates that AI integration in education has a wide-ranging impact and can be utilized across diverse subjects and disciplines to enrich the learning experience. However, the analysis also reveals that a small percentage of users have reservations about certain aspects of the application. These concern on the emphasis of the need for continuous improvement and refinement to address the specific issues raised by these users. Educators and developers need to consider this feedback and iteratively enhance the application's performance and usability to cater to a broader range of student's needs and preferences.

Similar findings from other research studies exploring the integration of AI in education (Qadir, 2023; Shen et al., 2023; Wardat et al., 2023) underscore the importance of ongoing research and development in the field. This iterative approach will ensure that AI technologies, like ChatGPT, continue to evolve and effectively support the educational process, providing students with a dynamic and engaging learning environment. The successful integration of AI in education holds significant promise for the future of learning. By harnessing the power of AI-driven learning object material, educators can create personalized and adaptive learning experiences that cater to individual student's strengths and weaknesses. This approach fosters better understanding, critical thinking, and problem-solving skills among students, leading to improved academic performance and overall satisfaction with the learning process (Srinivasa et al., 2022; Islam, 2023).

As the educational landscape continues to evolve, the positive impact of AI integration will likely be further explored and expanded upon (Kasneci et al., 2023; Rathore, 2023). Continued research and development in this area will pave the way for innovative and effective applications of AI technologies in education, transforming traditional learning approaches into modern, technology-driven, and student-centred educational experiences.

The learning performance results related to understanding concepts about water pollution indicate that, overall, students could answer the three types of given questions proficiently. Several factors contributed to this success, namely engaging learning media, diverse learning object formats, and test questions that aligned well with the taught material. The positive learning outcomes in understanding water pollution concepts can be attributed to the effective utilization of media, motivation, and cognitive load theories. Integrating engaging learning media, motivational elements, and well-designed learning materials enhanced the students' comprehension and performance in the learning process. These theories play a vital role in shaping the design and implementation of AI-integrated educational approaches, promoting a more student-centred and practical learning environment.

The successful learning outcomes can be attributed to the practical application of media theory. Engaging learning media, such as videos, posters, and books, captured the students' attention and facilitated a more interactive and immersive learning experience.

The integration of ChatGPT with Renderforest and Canva created visually appealing and informative learning materials, fostering a deeper understanding of the subject matter. According to media theory, using varied multimedia elements enhances knowledge retention and comprehension, making learning more enjoyable and effective (Chuang & Jamiat, 2023). When learners are exposed to a combination of visual, auditory, and interactive content, they are more likely to retain and understand the information presented (Cabual, 2021; Magana et al., 2019). Learners receiving information through multiple modalities can create stronger mental connections and associations with the content. The combination of text, images, and audio allows learners to form a more comprehensive understanding of the topic, as they can relate new information to their existing knowledge and experiences.

The motivation theory comes into play regarding positive learning outcomes. Using an AI-integrated learning approach with creative and visually appealing learning object material sparked students' interest and curiosity in water pollution. The students were motivated to explore the subject further and actively participate in the learning process by employing interactive learning materials and promoting active group discussions (Doucet et al., 2019). Integrating motivational elements aligns with the motivation theory, which emphasizes the significance of intrinsic and extrinsic motivation in enhancing the learning experience and promoting better retention and application of knowledge (Yoo & Huang, 2013). Educators foster intrinsic motivation by incorporating motivational elements that appeal to learners' interests, curiosity, and sense of autonomy, leading to a more profound and meaningful understanding of the topic.

On the other hand, extrinsic motivation involves external factors that influence individuals' behaviour and learning. While intrinsic motivation focuses on the inherent enjoyment of the learning process, extrinsic motivation complements it by providing additional incentives for learners to participate and excel in their studies. Educators create a positive and conducive atmosphere that fosters students' enthusiasm for learning by integrating motivational aspects into the learning environment (Ednie & Stibor, 2017).

The cognitive load theory is relevant to the student's successful performance in answering the test questions. The learning object material was carefully designed, considering the student's cognitive load, ensuring the information presented was well-structured and easily digestible. By breaking down complex concepts into manageable chunks and providing multiple representations of the content, the learning material minimized cognitive overload and facilitated information processing (Wickens & Carswell, 2021). The alignment of the test questions with the learning material was crucial in ensuring that the assessment process adhered to cognitive load theory principles. Cognitive load theory posits that learners have a limited capacity for processing information, and excessive cognitive load can impede learning and retention (Sweller, 2020).

Educators minimize cognitive burden and facilitate more effective information processing by designing test questions well-aligned with the material and avoiding unnecessary complexity. Aligned test questions assess the core concepts and key learning objectives covered in the learning material. These questions were carefully crafted to measure students' understanding of the fundamental principles without overwhelming them with irrelevant or extraneous details. By doing so, educators ensure that students' cognitive resources are allocated efficiently to the most critical aspects of the subject matter.

Furthermore, successfully applying cognitive load theory in designing the test questions contributes to enhanced information processing and retention. When students encounter test questions aligned with the material they have learned, it triggers schema activation, enabling them to access and retrieve relevant knowledge from their memory

(Paas & van Merriënboer, 2020). This process of schema activation aids in consolidating the known information and reinforcing long-term retention. Such questions may divert students' attention from the essential concepts and create confusion, ultimately impacting their performance on the assessment.

CONCLUSION

This research has demonstrated the potential of ChatGPT integrated with Canva and Renderforest in developing effective multi-representational learning object material. The creation of videos, posters, books, and test questions in multiple-choice, matching, and true/false formats showcases the versatility and practicality of AI-driven content creation. The seamless integration of these technologies allows for producing engaging and interactive educational materials that cater to diverse learning preferences. The positive student responses to the learning object material indicate that the AI-integrated approach is well-received and beneficial in enhancing science education. The high levels of agreement and satisfaction expressed by the students reinforce the effectiveness of the application in facilitating learning and promoting water pollution awareness. Moreover, the successful learning outcomes observed in students' understanding of water pollution concepts can be attributed to the practical application of media theory, motivation theory, and cognitive load theory. Integrating engaging multimedia elements, motivational elements, and well-designed learning materials enhances students' comprehension and performance in the learning process. By capitalizing on multimedia learning, educators create a dynamic, immersive learning experience that caters to various senses, promoting better information retention and comprehension. The successful implementation of AI technologies in education offers promising prospects for fostering critical thinking skills, supporting personalized learning experiences, and transforming the traditional educational paradigm. As AI continues to evolve, it is poised to play an increasingly pivotal role in shaping the future of education, making learning more accessible, inclusive, and impactful for students.

CONFLICT OF INTEREST

We declare there is no conflict of interest.

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