Science E-Module Based on Augmented Reality (AR) to Improve Students' Critical Thinking Skills: Systematic Literature Review

Putri Salsabila[1], Roza Linda[2], Muhammad Nasir[3]

Master of Science Education Study Program, Riau University, Pekanbaru, Indonesia

Background

The development of digital technology, especially augmented reality (AR), has brought innovation to education. AR combines real and virtual elements, creating an interactive and engaging learning experience, especially in science subjects. The use of AR in e-modules helps improve students' critical thinking skills by facilitating the understanding of complex concepts through visualization. We expect the development of AR-based e-modules to boost student engagement, enhance their analytical skills, and enhance their comprehension of science materials.

Research methods

This study is a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-analyses method, commonly called PRISMA. The articles used in this literature review are articles obtained using electronic data-based applications assisted by Harzing's Publish or Perrish, which include Google Scholar, Eric, Crossef, and ScienceDirect using keywords such as "augmented reality," "e-module science," "critical thinking skills," and "education.".

Inclusion Criteria	**1) Research articles published in 2020 – 2024,** **2) Research Topics on Development, E-Modules, Augmented Reality (AR), Critical Thinking Skills** **3) Literature from proceedings, Articles/Journals, theses, and scientific papers**
Exclusion Criteria	**1) Research articles that cannot be accessed in full** **2) Not in the field of Education**

Result Relevant Articles

Authors	Year	Title	Research result
Alfina Salsabila, Pramudya Dwi Aristya Putra, Zainur Rasyid Ridlo	2024	DEVELOPMENT OF INTERACTIVE TEACHING MODULES USING AUGMENTED REALITY IN SCIENCE LEARNING IN JUNIOR HIGH SCHOOL TO IMPROVE CRITICAL THINKING SKILLS	The results of this study state that the interactive learning module assisted by augmented reality to improve critical thinking skills of grade VIII students is included in the very valid category with a percentage of 90%, broken down very practically with a percentage of 93%, broken down very practically with a percentage of 90%, and broken down moderately in the effectiveness test using an N-gain value of 0.68. Based on this, the interactive learning module assisted by augmented reality that was developed is very feasible and practical to use in learning activities.
Ahmad Ariadi, Ahmad Suriansyah, Ratna Purwanti	2023	IMPLEMENTATION OF EXCELLENT LEARNING MODEL AND AUGMENTED REALITY MEDIA TO IMPROVE STUDENTS' CRITICAL THINKING SKILLS	The problem in this study is the low learning activity and high-level thinking skills of students in learning. The cause is because learning is not centered on students and has not encouraged the development of high-level thinking skills. This will have an impact on low student learning outcomes and problem-solving abilities. Efforts to overcome these problems are by implementing the Excellent model and augmented reality media.

Authors	Year	Title	Research result
Aprilia Lulita Nadya Hidayat, Nur Ahmad, Zainur Rasyid Ridlo, Pramudya Dwi Aristya Putra, Firdha Yusmar	2024	Developing an Augmented Reality-Based Textbook on Heat and Transfer Materials to Improve Students Critical Thinking Skills	Based on the results, augmented reality-based textbooks are very valid, practical, and effective in showing an increase in the critical thinking skills of junior high school students, with the observed increase falling into the high category, specifically by 0.71.
Dini Ashari	2023	ANALYSIS OF THE UTILIZATION OF AUGMENTED REALITY (AR) LEARNING MEDIA TO IMPROVE CRITICAL THINKING SKILLS	The results of the study show that learning media based on augmented reality will give students a lot of practice in the process of thinking, understanding, and analyzing existing problems. In addition, the use of augmented reality as a learning medium can have an influence and be able to improve thinking skills in students.
Ratna Azizah Mashami, Khaeruman Khaeruman, Ahmadi Ahmadi	2021	Development of Integrated Contextual Learning Modules Augmented Reality to Improve Students' Critical Thinking Skills	The results of this study include: 1) the module is declared very feasible with an average score of 90%; 2) the module can improve students' critical thinking skills as indicated by a significant value of 0.00 at a 95% confidence level and an average N-gain score of 58% (moderate); and 3) students gave very good responses to the learning process using the module. Thus, the Augmented Reality integrated contextual learning module has been successfully developed.

Authors	Year	Title	Research result
Rizka Oktaviyanti, Ulum Fatmahanik, Wirawan Fadly	2023	Development of STEM-Based Teaching Materials by Utilizing Augmented Reality to Improve Critical Thinking Skills	The teaching materials are very good at providing students' interest in learning, and the materials and language are easy to understand. The teaching materials are also effective in improving students' critical thinking skills in vibration, wave, and sound materials with an N-gain score of 60.34 or a moderate improvement category.
Tiya Ayu Retnaningtiyas, Nadi Suprapto, Hainur Rasid Achmadi	2021	Literature Study on the Utilization of Augmented Reality Media to Improve Students' Critical Thinking Skills	research related to the use of augmented reality media that has been conducted with the aim of describing and interpreting relevant information related to the use of augmented reality media to improve critical thinking skills in students. From the results of the literature study, it can be concluded that the use of augmented reality media is effective in improving students' critical thinking skills.

Discussion

According to several articles, students are now more enthusiastic about learning that is relevant to real life and utilizes modern technology. Augmented reality (AR) technology allows the integration of real and virtual elements with an accurate tracking system to increase interactivity. AR-based learning media can train critical thinking skills such as interpretation, analysis, and explanation, as well as increase motivation and ease in understanding concepts. With AR, learning becomes more interactive and meaningful and encourages critical thinking patterns related to everyday problems.

Conclusion

Based on the results and discussion, it can be concluded that by utilizing current technological developments in the learning process, such as the development of E-Module Science learning media based on augmented reality, students will practice a lot about the thinking process and understanding and analyzing existing problems. In addition, the use of Augmented Reality as a learning medium can have an influence and be able to improve critical thinking skills in students. AR-based E-module Science has great potential to be applied in learning to improve students' critical thinking skills.

Sekian

Terima Kasih