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Recent Trends in Virtual Reality for Meaningful and Fun Science Learning: A Systematic Literature Review

Iwan Purnama[1], Arie Wahyu Prananta[2], Tiok Wijanarko[3*]

[1] Universitas Labuhanbatu, Rantau Prapat, Indonesia.
[2] Universitas Trunojoyo Madura, Madura, Indonesia.
[3] Faculty of Science Education, Universitas Negeri Padang, Padang, Indonesia.

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Corresponding Author:
Tiok Wijanarko
tiokwijanarko@fip.unp.ac.id

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Abstract: The use of Virtual Reality in education can revolutionize the learning experience of students through immersive and captivating encounters that can enhance their understanding of the subject can provide a meaningful and enjoyable Virtual Reality experience. Where the research objective is to examine the latest trends in Virtual Reality for meaningful and enjoyable science learning: Systematic Literature Review. The review was conducted based on state-of-the-art methods using the preferred reporting items for reviews and meta-analyses (PRISMA) guidelines. The results of this research explain that there are Learning Trends in the Future, namely: Collaboration, Learning Inspiration from a Young Age, Rapidly Growing Online Learning, Using Virtual Reality for Learning, Learning with AI Technology; Uses of Virtual Reality in science learning: Use of Virtual Reality as a learning medium, Use of Virtual Reality as a competency testing medium, Learning & competency testing in the Film Industry; The essence of science learning: Science as a way of thinking, Science as a way of inquiry, Science as a building of knowledge, Science as a form of interaction between technology and society.

Keywords: Education; Science learning; Virtual reality

Introduction

In learning, many students feel bored and tired of participating in learning because how learning is delivered is considered monotonous and just like that. Therefore, educators are now expected to be able to create effective and interesting learning media for students. One learning media that is quite interesting is using the VR (Virtual Reality) learning model (Santos Garduño et al., 2021). Virtual Reality is a technology that allows users to directly experience or interact directly with their environment, even if only through cyberspace or a computer (Park et al., 2018). It could be said that VR is a technology created so that a person can directly experience the surrounding environment.

In learning science, of course, we can only hear stories about learning science (Kuhn & Müller, 2014). Of course, with Virtual Reality, it is as if we are observing the world analytically, completely, and carefully, and connecting one natural phenomenon with another, thereby forming a new perspective on the object being observed. The mental activities of scientists encourage curiosity, imagination, and strong reasoning in trying to describe and explain natural phenomena (Ernst & Burcak, 2019). Virtual reality is a new technology that provides computer-generated simulations of environments that can be interacted with in real time. VR technology has been used in a variety of industries, including medical training, engineering, and entertainment, but also has significant educational potential. VR technology in education allows students to interact with real-life scenarios without leaving the classroom (Żammit, 2023).

The use of VR in education can revolutionize students' learning experiences through immersive and captivating encounters that can enhance their

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understanding of the subject. Providing interactive VR experiences has the potential to connect theoretical concepts with practical applications, thereby equipping students with the confidence to face future challenges (Romano et al., 2023). With continued technological advances, VR will likely become an important component in the education system, offering students a powerful means to strengthen their learning.

One of the main advantages of implementing VR in education is that it provides a more immersive and engaging learning experience. VR can take students to places that are difficult to access, such as historical monuments, outer space, or even inside the human body. Students can better understand a subject and engage with learning material when they are given a unique perspective (Hew et al., 2020). Additionally, VR in education can enhance collaborative learning (Petersen et al., 2023). Learners can interact with their peers and the virtual environment, making the experience more active. It can also offer students a personalized learning experience by allowing them to explore cyberspace at their preferred pace and manner. Students can improve their understanding of course material by using VR technology to provide personalized feedback (Ironsi, 2023).

VR has important benefits in education as it offers a cost-effective solution (Marougkas et al., 2023). Rather than organizing physical models or field trips, educational institutions can produce virtual environments that can be accessed by many students simultaneously. Additionally, technology can create a safe and orderly learning environment for students, especially when working with complex machinery or hazardous materials (Zou & Yu, 2022). Educational learning theory refers to a framework that explains how people acquire knowledge, skills, and attitudes. The goal is to understand the learning process and the various factors that influence it (Matovu et al., 2023). There are various learning theories, including behaviorism, cognitivism, constructivism, and humanism.

Understanding learning theories is critical for educators because they offer a foundation for developing effective teaching approaches, learning materials, and evaluation tools. When teachers understand how people learn, they can adapt their instruction to meet each learner's unique needs and facilitate deeper learning. Additionally, knowledge of learning theories allows teachers to create encouraging learning environments that increase student engagement, motivation, and success. In the realm of VR, various learning theories can be used to design effective VR-based learning experiences (AlGerafi et al., 2023). However, research in this area is still relatively new, and more research is needed to understand the most effective ways to design and implement VR applications for education.

Designing effective VR-based learning experiences relies heavily on incorporating learning theories (Matovu et al., 2023). Leveraging these theories in VR can enable educators to design immersive and interactive learning experiences that engage students and facilitate more efficient and effective learning. With the advancement of VR technology, it is increasingly important for educators to understand how to apply learning theories in effectively designing VR-based learning experiences. Science is a way or method of studying the natural environment and how to uncover the mysteries within it systematically so that science is not just mastering a collection of knowledge in the form of facts, and concepts, but a process of discovery (Miedema, 2022).

Previous research has been conducted on the impact of virtual reality use on the teaching and learning of vectors (Campos et al., 2022). The effectiveness of virtual reality-based technology on anatomy teaching: a meta-analysis of randomized controlled studies (Zhao et al., 2020), Analyzing augmented reality (AR) and virtual reality (VR) recent developments in education but no research examines the latest trends in Virtual Reality for meaningful and enjoyable science learning: Systematic Literature Review. Based on the above background, this research aims to examine the latest trends in Virtual Reality for meaningful and enjoyable science learning; Systematic Literature Review.

Method

We conducted this study as a systematic review following PRISMA guidelines (Page et al., 2021). The PRISMA guidelines provide several things to consider in preparing a systematic review. In this study, we will mainly focus on several main items: Future Learning Trends, the usefulness of Virtual Reality in science learning, and the nature of science learning. This helps form the basis of our assessment. Initially, we gathered the latest studies on the latest Trends of Virtual Reality for meaningful and fun Science learning through; Systematic Literature Review, based on several selected keywords. Then, we apply eligibility criteria to the collection. We selected only literature published in 2015 or later to provide an overview of current trends. Apart from that, we limited the type of literature to only literature in the form of journals and proceedings.

Result and Discussion

Preferred Reporting Items for Systematic Reviews (PRISMA) was the reporting technique used in this study. The research was conducted methodically during

the required research phases. The information provided is comprehensive and unbiased and aims to combine relevant research results. The steps of a systematic literature review include developing research questions, literature searches, screening and selecting relevant articles, screening and selecting the best research results, analysis, synthesis of qualitative results, and preparation of research reports. Writing the background and objectives of the research, collecting research questions, searching the literature, selecting articles, extracting articles, assessing the quality of basic studies, and summarizing the material are steps in the systematic literature review research process.

Complete articles published in international journals 2015-2023, indexed in databases, and on the theme Latest trends in Virtual Reality for meaningful and fun science learning; Systematic Literature Review.

Table 1. Future Learning Trends

Source	Future Learning Trends
(Klockmann & Von Schenk, 2023); (Liang et al., 2018); (Dang et al., 2021); (Urbano & Ardanuy, 2020)	Collaboration
(Haleem et al., 2022); (Darling-Hammond et al., 2020); (Parker et al., 2022)	Inspiration for Learning from a Young Age
(Salama & Hinton, 2023); (Yu et al., 2024); (Palvia et al., 2018)	Rapidly Growing Online Learning
(Al-Ansi et al., 2023)	Using VR for Learning
(Zhang & Aslan, 2021)	Learning with AI Technology

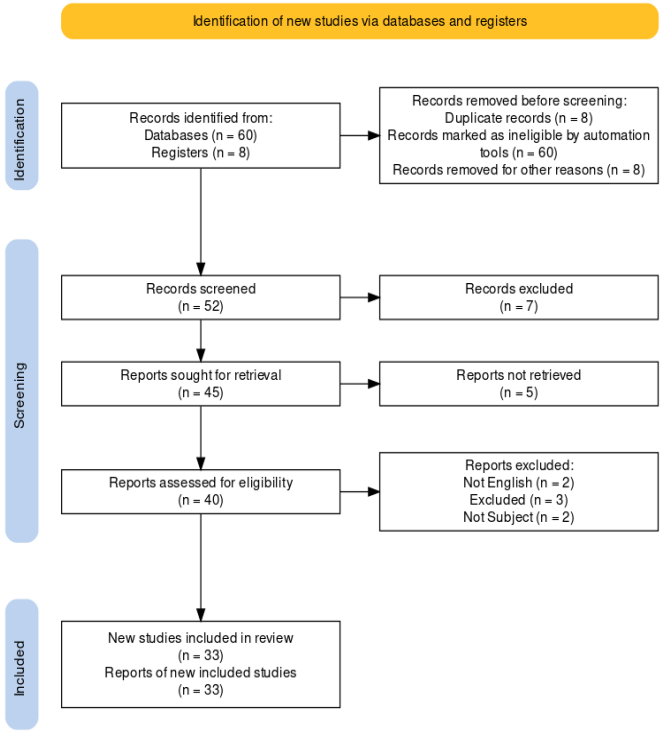

Figure 1. Flow of the literature search process based on PRISMA guidelines

There are several Learning Trends in the Future:

Collaboration

When studying, someone needs to complement it with other people so that there are more points of view. In other words, collaboration is needed to find solutions to various problems. In the future, learning about collaboration is very necessary rather than patronizing each other. This is because in real life collaboration is needed to encourage mutual awareness of learning together. Cross-field collaboration in the modern scientific world, for example. For someone who is part of a science and technology project, of course, not only science experts but also people from across other scientific fields need to collaborate to get maximum results.

Inspiration for Learning from a Young Age

It is not surprising that future education will start from an increasingly younger age. This is because today's young children find it easier to adopt and retain information and develop their interests. As children grow and begin to explore the world around them, you can use a STEM (Science, Technology, Engineering, Mathematics) approach to educate children and inspire them to be passionate about learning. This awareness will also be accompanied by an educational approach that no longer dictates based on the system but guides based on talents or tendencies that they like.

Rapidly Growing Online Learning

Online-based education or e-learning has become a new trend in the world of education during the pandemic. Online learning was initially carried out for independent learning, but now it has developed rapidly. This development is enriched by extensive learning resources, interesting videos, and a curriculum that complements the textbooks used by students at school.

In the future, this development will accelerate so that it can create a fun and interesting online learning environment and make storing information easier to learn. Learning no longer only focuses on giving written assignments but also on approaching the problems they face in everyday life.

Using VR for Learning

The development of technology also allows students' learning tools in the future to change. It is not impossible that in the future students will use sophisticated technological equipment such as Virtual Reality (VR). VR will be interesting for students and can make learning concrete, and no longer abstract. VR allows students to learn in a completely digital environment. Additionally, VR also allows teachers to take them on great learning adventures without having to leave the classroom. For example, students can see clearly how the solar system is in the universe by traveling through space in a VR spaceship, or to explore the intricacies of the human body. With VR technology, learning can encourage the development of imagination and a higher-quality learning process.

Learning with AI Technology

Not only VR, Artificial Intelligence (AI) technology could become a learning trend in the future. AI can change the way teachers teach, mapping needs and analyzing them. Of course, this will optimize the learning process to achieve better goals. By adopting technology in learning, teachers can go one step further to facilitate students' learning process and provide better results than before.

Table 2. Uses of Virtual Reality in Science Learning

Source	Uses of Virtual reality in science learning.
(Kurniawati et al., 2020); (Supriadi & Hignasari, 2019); (Ginting et al., 2023)	Use of Virtual Reality as a learning medium
(Wang et al., 2023); (Elme et al., 2022); (Safadel & White, 2020); (Motejlek & Alpay, 2023)	Use of Virtual Reality as a competency test medium
(Bao, 2022); (Trudeau et al., 2023); (Larson & Sutton, 1978); (Huang et al., 2022); (Laine et al., 2023); (Wong et al., 2023); (Johnson-Glenberg et al., 2023)	Learning & Competency Test in the Film Industry

There are several uses for virtual reality in science learning. Use of Virtual Reality as a learning medium: Learning media is anything that can be used to channel messages from the sender to the recipient to stimulate the thoughts, feelings, attention, and interests, as well as the will of students in such a way that the learning process occurs to achieve effective learning goals. Learning media can also be interpreted as a functional and useful tool for conveying learning messages. Competency testing is a technical and non-technical assessment process through collecting relevant evidence to determine whether a person is competent or not yet competent in a particular unit of competency or qualification. Competency tests also require an environment (facilities, resources) that can support participants to demonstrate their abilities.

Therefore, the use of media for competency testing needs to be considered. Learning & Competency Test in the Film Industry. Some learning models used for professions in the film industry include Small group discussion, role play and simulation, case study, discovery learning, project-based learning, and inquiry, each of these learning models has its learning outcomes. Subjects related to the field of film production are film production management, video editing, film aesthetics, screenwriting, directing, film sound design, film artistic design, and film research.

Table 3. The Nature of Science Learning

Source	The nature of science learning
(Taber, 2017); (Smith & Corrigan, 2020)	Science as a way of thinking
(Widowati et al., 2017); (Lederman & Lederman, 2019)	Science as a way of inquiry
(Michel & Neumann, 2016); (Moutinho et al., 2015)	Science as a building of knowledge
(Svendsen, 2021)	Science as a form of interaction between technology and society

The essence of science learning is Science as a way of thinking: Science as a way of thinking has seven attitudes, namely belief, curiosity, imagination, reasoning, cause, and effect relationships, self-testing, and doubt, as well as being objective and open; science as a way of inquiry; science uses scientific methods to build knowledge consisting of observing, collecting data, developing hypotheses, experimenting, and making conclusions; science as a building of knowledge. Building knowledge results from many scientific fields that demonstrate the creative results of human discovery.

Building knowledge in the form of facts, concepts, laws and principles, theories and models; science as a form of interaction between technology and society science, technology and society influence each other. Science uses technology to answer questions about nature and society to play a role in improving products that many scientists, engineers, and technicians utilize. Science is a system of knowledge about nature that

contains data from controlled observations and experiments. Science explains as data is obtained, existing theories are used to explain results from observations.

Conclusion

Science is a science that studies nature and events that occur in nature through a group of scientific processes that include the nature of science, namely as a way of thinking, as a way of inquiry, as building knowledge, as well as the relationship between technology and society. In science learning, virtual reality technology is needed. meaningful and fun. Virtual reality has many uses. Using Virtual Reality as a learning medium, the use of Virtual Reality as a learning medium has a positive impact on students in a meaningful and enjoyable learning process.

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Conceptualization, I. P., A. W. P., T. W.; methodology, I. P.; validation, A. W. P. and. T. W; formal analysis, I. P.; investigation, A. W. P, and T. W.; resources, I. P. and. A. A. W. P; data curation, T. W.: writing—original draft preparation., I. P.; A. W. P. And T. W.; writing—review and editing, I. P.: visualization, T. W and I. P. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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