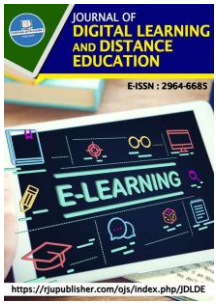

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Virtual Reality as A Digital Learning Innovation to Enhance the Skills of Students: A Systematic Review

Ruth Rize Paas Megahati S

Aquaculture Study Program, Universitas Nahdlatul Ulama Sumatera Barat, Padang, Indonesia

Abstract

A VR is a significant option for improving learning activities in schools, consistent with contemporary educational trends and technical progress. Prior studies reveal a deficiency in thorough assessments assessing VR as a digital learning innovation, particularly focused on improving student abilities. This study aims to analyze and highlight several research publications that examine virtual reality as a digital learning innovation to improve student skills. We chose the PRISMA diagram to conduct the systematic review process. Based on the established inclusion criteria, we identified 20 potential articles for the literature review. The selected articles emphasize the role of VR as a digital learning innovation aimed at enhancing student skills. VR is a promising digital learning innovation that can significantly enhance elementary school students' skills and engagement. This study collects and analyzes relevant research findings to conclude that VR is a digital learning tool for improve ESS skills. The implications of using VR in education are significant, offering opportunities to transform traditional learning environments and equip students with the skills needed for future success. However, careful consideration and strategic planning are essential to address the challenges and maximize the benefits of this innovative technology.

Keywords: virtual reality, digital learning, innovation learning, student skill, elementary school

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Introduction

VR in educational environments provides revolutionary advantages that improve student skills. By creating immersive environments, VR enhances student engagement, thereby improving memory and comprehension of intricate subjects. Virtual reality captivates students' focus via interactive and

immersive experiences, resulting in heightened motivation and involvement in educational activities (Analyti et al., 2024; Portuguez-Castro & Garduño, 2024). Research demonstrates that VR apps markedly enhance student happiness and engagement, especially among female students, underscoring their capacity to address varied learning requirements (Portuguez-Castro & Garduño, 2024). VR makes it possible to simulate real situations without any risk, which lets students explore real-life issues in subjects like history and physics (Analyti et al., 2024; Mahmoudi-Dehaki & Nasr-Esfahani, 2024). It supports constructivist learning theories by encouraging active participation and hands-on learning, which are important for understanding things deeply (Sousa et al., 2024), according to Mahmoudi-Dehaki and Nasr-Esfahani. Students can better understand abstract topics by controlling virtual objects and exploring environments that would be difficult to access otherwise. VR offers immersive learning that is unattainable through conventional learning (Mahmoudi-Dehaki & Nasr-Esfahani, 2024). Therefore, VR is needed as a digital learning innovation to improve students' skills, especially ES.

Digital learning is a learning method that utilizes digital technology to deliver learning materials, such as VR. VR is developing as a disruptive digital learning innovation, markedly improving educational experiences across diverse fields (Manoharan et al., 2024). Through the creation of immersive environments, VR enhances engagement and understanding of intricate topics, rendering the learning experience more participatory and enjoyable. This revolutionary strategy enhances conventional educational practices while also presenting fresh paradigms for instruction and learning. VR technologies, including simulations and immersive games, have demonstrated an enhancement in student engagement and motivation. For example, a study on electrical circuits demonstrated that VR significantly improved comprehension and engagement compared to traditional methods (Albarracin-Acero et al., 2024). Researchers found that VR media in primary education increases students' interest in learning, demonstrating its effectiveness in fostering enthusiasm for academic subjects (Nisatulloh et al., 2023). VR allows for virtual field trips, scientific simulations, and interactive learning experiences, which can make abstract concepts more tangible. For example, a VR simulation in immunology helps students visualize complex processes, enhancing their understanding of host immunity (Pandit et al., 2024). Schools are increasingly adopting the integration of VR in curricula as a promising strategy for educational innovation (Ramos & Júnior, 2024), especially in ES.

VR functions as a revolutionary digital educational instrument that improves ESS competencies in multiple areas. Through the provision of immersive and interactive experiences, virtual reality enhances engagement, motivation, and educational outcomes (Salmiyanti et al., 2023). VR facilitates skill enhancement in elementary education, namely in the areas of 21st-century skills, language acquisition, and spatial ability development. VR fosters critical thinking, creativity, and collaboration among students, which are vital elements of 21st-century skills (Erita et al., 2024). The incorporation of VR in educational settings has been associated with increased student involvement and motivation, resulting in improved academic achievement (Erita et al., 2024). VR significantly enhances English-speaking skills by providing immersive environments for practice, hence improving grammar and vocabulary usage (Wu & Hung, 2022). The interactive characteristics of VR promote students' eagerness to speak, while it may not substantially influence pronunciation and fluency (Wu & Hung, 2022). VR technology enhances spatial skills by converting abstract concepts into interactive three-dimensional environments, which is especially advantageous for children who have difficulties in mathematics (Chao & Chang, 2020). The implementation of VR in geometry teaching has demonstrated improvements in learning efficacy and ESS engagement (Chao & Chang, 2020).

Riyana and Setiawan (2023) were the prior academics to look into VR as a way to improve the skills of ESS skill. They looked into how 3D interactive VR media could help elementary school students learn these subjects better. The study's findings demonstrate that 3D interactive VR media promotes students' learning abilities, improves educational outcomes, and serves as a significant enhancement to

teaching approaches in elementary education. Cardona-Reyes et al. (2022) discovered that VR significantly enhances the educational experience and competencies of elementary school children through immersive, individualized, and engaging learning methods. The results demonstrate that with proper implementation and design, VR can function as a digital teaching instrument in modern education. Laine et al. (2023) did similar research that showed VR may improve student engagement and learning in elementary schools. This shows how important it is to include student input in the creation of these technologies. According to Oubibi et al. (2022), the incorporation of VR technology in basic education not only augments student involvement and creativity but is also straightforward to deploy, rendering it a promising strategy for contemporary education. A VR may function as a significant option for improving learning activities in elementary schools, consistent with contemporary educational trends and technical progress. Previous research indicates a lack of comprehensive reviews examining VR as a digital learning innovation aimed at enhancing ESS's skills. This study aims to analyze and highlight several research publications that examine virtual reality as a digital learning innovation to improve ESS skills. We have designed this research to address the following research questions (RQs):

1. What are the key benefits of using VR in educational settings?
2. How is VR a digital learning innovation?
3. How does VR as a digital learning innovation improve ESS skills?

Method

Researchers use a systematic review as a research methodology to systematically find, evaluate, and analyze all relevant research findings related to a particular research question. The methods used in this systematic review are procedures, analysis, and data synthesis.

2. 1 Procedure

Researchers use a systematic review as a research methodology to systematically find, evaluate, and analyze all relevant research findings related to a particular research question. A systematic review is a planned way of putting together research findings. It has clear criteria for who can be included and methods that can be used again and again to avoid bias (Brignardello-Petersen et al., 2024; Tranfield et al., 2003). We conducted an article search on 3 databases (Scopus, DOAJ, and Google Scholar) using the Publish or Perish (PoP) application. The PoP program is desktop software developed to aid researchers in organizing bibliographic data and acquiring bibliometric indications (Michán, 2023). Furthermore, we selected articles with a publication period spanning from 2016 to 2023. The keywords used were VR, digital learning, innovation learning, student skills, and elementary school.

2. 2 Analysis

We used the PRISMA diagram to show how a systematic review works. The PRISMA diagram can enhance transparency, reproducibility, quality, and communication of research findings. The PRISMA diagram includes three phases: identification, screening, and inclusion (Figure 1).

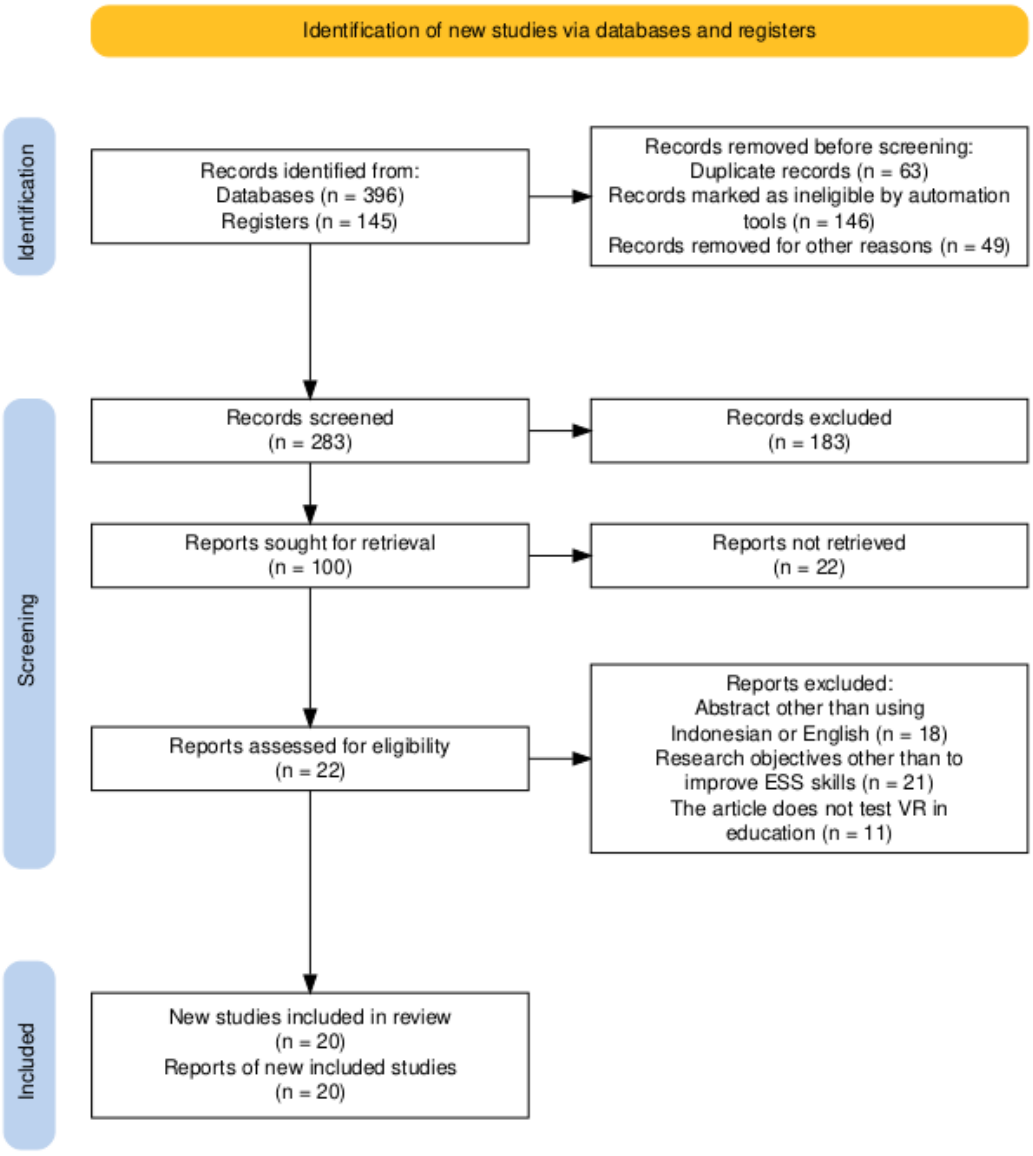

Figure 1: PRISMA flow diagram

Figure 1 displays 63 articles identified as duplicates, 146 articles failing to match the established criteria, and 49 articles eliminated for other reasons. Consequently, 283 papers progressed to the screening phase. During the screening phase, we discarded 105 articles and retained 78. During the inclusion phase, we identified 20 prospective articles for the literature review step. Subsequently, we examined the titles, abstracts, and entire texts of the articles to identify those who satisfied the predetermined inclusion and exclusion criteria. The inclusion and exclusion criteria for this study are shown in Table 1.

Table 1: The inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Research examines VR as a digital learning innovation to improve ESS skills.	The study did not examine VR as a digital learning innovation to improve ESS skills.

Articles were harvested from three databases (Scopus, DOAJ, and Google Scholar).	Articles harvested from databases (Copernicus, Moraref, and WorldCat).
The research subjects studied are ESS.	The subjects of the study were middle and high schools.
Potential articles are published from 2016 to 2023	Potential articles were published outside of 2016 to 2023.
The research method is quantitative and qualitative or a combination of both.	The research method was not quantitative and qualitative or a combination of both.
Articles already have a Digital Object Identifier (DOI).	Articles no longer have a Digital Object Identifier (DOI)

2. 3 Data Synthesis

Wang et al. (2023) say that the goal of data synthesis in SLR is to combine the results of several studies to better understand a certain research question. We conducted data synthesis on RQ1, RQ2, and RQ3 to get the most recent findings. Despite the restricted quantity of papers and varied methodologies, we refrained from performing a quantitative meta-analysis. We opted for a narrative synthesis strategy, which systematically integrates all findings from the selected studies. We acquired 8 articles about RQ1, 7 papers related to RQ2, and 5 publications concerning RQ3 (Figure 2). We examined and emphasized 20 prospective publications based on the first author's name, country of origin, result, and conclusions.

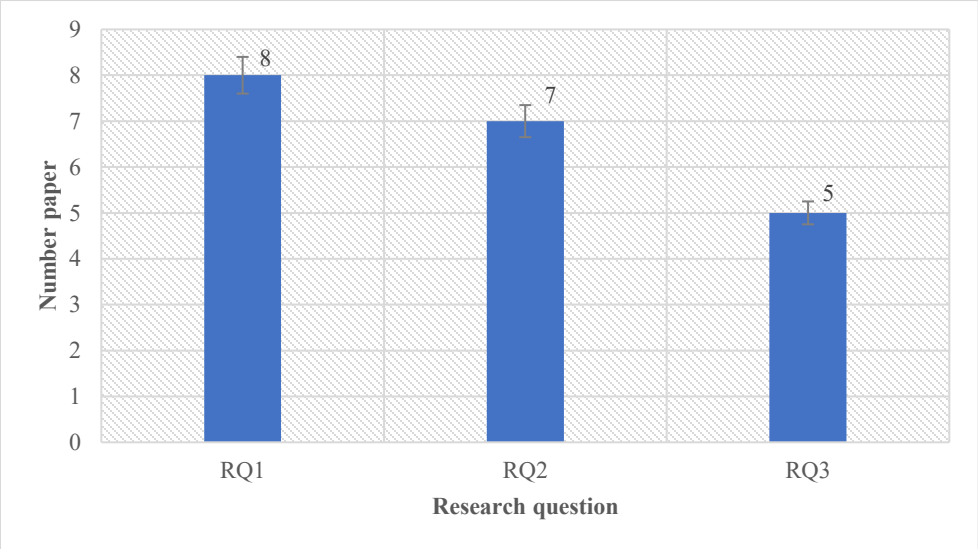

Figure 2. Number of articles based on RQ

3. Results and discussion

We have successfully conducted a study of VR as a digital learning innovation to improve ESS skills: a systematic review. The results of the systematic review are presented in Tables 1, 2, and 3.

RQ 1: What are the key benefits of using VR in educational settings?

The implementation of VR in educational settings presents some substantial advantages that can enhance the quality of learning (Table 1).

Table 1. The key benefits of using VR in educational settings

Author	Country	Results	Conclusion
Xu et al. (2023)	China	VR may significantly enhance instructional methodologies and optimize learning results for ES students	VR in education presents revolutionary potential, accommodates varied learning styles, and is poised to influence the future of educational methodologies.
Burciu et al. (2023)	Romania	Incorporating VR technology into educational environments can markedly improve pedagogical methods, rendering learning more captivating and effective for ESS.	The incorporation of VR in educational environments can revolutionize pedagogical methods, enhancing engagement and efficacy for ESS.
Chen et al. (2023)	China	Promote the incorporation of immersive VR experiences in educational methodologies to enhance learning results in elementary school	VR is an effective instrument for augmenting student participation in education, particularly in elementary schools.
Rafiq et al. (2022)	Indonesia	Incorporating VR technology into educational environments can markedly improve pedagogical methods, rendering learning more captivating and effective for pupils.	The integration of VR in educational settings can transform teaching approaches, improving engagement and effectiveness for students.
Sharma & Sharma (2022)	India	VR apps can markedly improve student engagement and learning outcomes by offering transformative, immersive experiences that address varied learning requirements.	VR applications can substantially improve educational experiences by enhancing engagement, accommodating various learning styles, and facilitating metacognitive skills.
Chi & Idris (2021)	Malaysia	a compelling argument for the incorporation of VR technology in educational environments,	VR has the potential to transform education by

		emphasizing its capacity to augment learning experiences, promote efficiency, and facilitate improved communication between students and educators	enhancing learning experiences, increasing engagement, and addressing deficiencies in traditional educational environments.
Alshammari, (2019)	Saudi Arabia	VR offers distinctive prospects for advancing educational methodologies and warrants additional investigation and application in academic environments to enrich teaching and learning experiences.	As VR technology advances, its educational uses will proliferate. Educators and authorities are advocating for the investigation and adoption of virtual reality to enhance students' learning experiences.
Rafiq et al. (2022)	Qatar	VR technologies markedly enhance student engagement and comprehension in engineering education, rendering intricate subjects more accessible and participatory.	We anticipate a broadening of VR technology's use in education as it advances and becomes more accessible, offering more opportunities to enhance student learning and engagement in engineering fields.

Table 1 contains eight articles that examine the key benefits of using VR in educational settings. The literature review of the eight articles reveals that VR is a proven tool for enhancing the quality of education. VR offers an engaging and interactive educational experience, enabling students to realize their full potential and enhance their skills. Other researchers' findings support the results of this study, namely, VR offers simulations of real-world situations, allowing students to interact with content actively (Analyti et al., 2024). VR-integrated role-playing games have demonstrated the capacity to augment immersion and motivation, resulting in enhanced involvement in educational activities (Chen et al., 2023). Research indicates that virtual reality improves memory retention and understanding of complex topics by allowing pupils to interact with information directly (Goi, 2024). The utilization of VR in vocational education has demonstrated improved comprehension and engagement among students (Indriati, 2023). Notwithstanding its advantages, the implementation of VR in education encounters obstacles, including substantial expenses, technological constraints, and the necessity for educator training (Analyti et al., 2024). Moreover, although VR improves engagement, it may require additional instructional support to optimize learning outcomes (Chen & Syu, 2024). VR markedly improves student engagement in lessons by establishing immersive and interactive learning environments.

VR enables students to envision intricate topics and engage in experiential learning, something conventional approaches often lack. The incorporation of VR in education enhances engagement and cultivates critical thinking and problem-solving abilities, which are vital for lifelong learning. VR enables students to comprehend intricate topics and engage in experiential learning, which conventional techniques often lack. VR replicates real-world events, allowing students to investigate disciplines such as physics and history in a safe environment (Analyti et al., 2024). The immersive quality of VR engages pupils, resulting in increased enjoyment and motivation, especially among female students (Castro & Garduño, 2024). VR enhances understanding of intricate subjects through visuals and simulations, thus

improving the efficacy of learning (Paramita et al., 2024). Research suggests that VR enhances retention rates and academic performance by honing cognitive abilities and fostering active learning (Goi, 2024).

RQ2: How is VR a digital learning innovation?

VR has transformed how we acquire knowledge and engage with information (Table 2). The technology provides an immersive and engaging educational experience, allowing users to see themselves in another environment**.**

Table 2: VR as a digital learning innovation

Author	Country	Results	Conclusion
Nisatulloh et al. (2023)	Indonesia	The implementation of VR learning media at Karangsari 2 State Elementary School effectively enhanced student engagement and enthusiasm for learning, illustrating the advantageous impact of technological integration in education.	There are potential benefits to using virtual reality as a digital learning innovation media in elementary education. By enhancing interactivity and immersion, VR can cultivate a more engaging and efficacious educational atmosphere for pupils.
Liu, (2023)	Philippines	The future of design education depends on collaboration among educational institutions, educators, and technology vendors. This collaboration is crucial for addressing current difficulties and improving the quality of education in environmental design in learning innovation	Emphasize the significance of incorporating digital tools such as virtual reality into environmental design education to improve learning outcomes, stimulate creativity, and equip students for future challenges in the field.
Rodriguez-Salvador & Algarra-Chavez (2023)	Mexico	These findings highlight the capacity of VR to significantly improve teaching methodologies using VR digital as a media learning innovation	Virtual reality as a VR digital media has the potential to revolutionize engineering education by increasing motivation, encouraging teamwork, and providing innovative resources that prepare students for their future careers.
Paxinou et al. (2022)	Greece	The VR technology application effectively enhances student engagement, provides vital analytics for instructors, and offers a customizable learning environment for science laboratory courses.	The integration of VR technology in remote scientific education not only augments student engagement and proficiency with laboratory equipment but also provides educators with essential insights

			to refine their pedagogical approaches
Lam et al. (2021)	Vietnam	The pandemic's issues necessitate educational reform, and advocates are pushing for the use of VR technology to boost the effectiveness of online learning.	The incorporation of VR technology into online education can mitigate the obstacles encountered during the pandemic, resulting in enhanced participation, interaction, and overall learning efficacy.
Eisenlauer, (2020)	Germany	Educational environments can effectively employ VR, highlighting the necessity for a combination of technological and literacy competencies.	The fundamental role of digital literacies in VR education highlights the accessibility of VR development for all students and provides a practical framework for creating stimulating learning environments.
Fabris et al. (2019)	Australia	VR possesses potential as a learning innovation its efficacy is predominantly contingent upon deliberate execution and the amalgamation of VR with alternative pedagogical approaches.	VR possesses the capacity to serve as a significant teaching instrument; nevertheless, its efficacy is predominantly contingent upon the manner of its implementation

In Table 2, there are 7 articles published from 2019 to 2023. All seven articles examine VR as a digital learning innovation. The results of the literature review show that innovative pedagogical approaches employing VR for experiential learning have garnered prominence in diverse educational domains. VR as a digital learning innovation, enhances student engagement and understanding by providing immersive experiences that traditional education cannot offer (Eisenlauer, 2020). Employing VR project-based learning as a digital educational innovation can integrate virtual reality to establish dynamic environments in which students engage in real-world problems (Tian, 2024). VR as a digital learning innovation, has proven its educational efficacy in augmenting student engagement and enhancing outcomes through immersive, hands-on experiences. VR technology enables students to examine human anatomy in a lifelike virtual environment, fostering independent exploration and collaborative learning (Lam et al., 2021). Students can examine virtual organs and view anatomical structures from various angles, hence enhancing their comprehension of complex topics (Farajpour et al., 2024). VR platforms designed for history education allow students to interact with historical events in a simulated environment, enriching their sensory experience and promoting a more profound comprehension of the subject. This method has been demonstrated to improve the efficacy and quality of history education (Cieslowski & Haas, 2024).

The incorporation of VR in educational environments offers several advantages and drawbacks that influence its efficacy as a digital learning instrument. VR's immersive nature keeps students more interested and encourages hands-on learning by letting them do practical simulations that aren't possible

with other methods (Paxinou et al., 2022). Nonetheless, obstacles such as elevated expenses and accessibility concerns impede its extensive implementation. VR engages students, resulting in enhanced recall and comprehension of intricate subjects (Analyti et al., 2024). It facilitates experiential learning through virtual field trips and simulations, which are especially advantageous in STEM and vocational education (Mahmoudi-Dehaki & Nasr-Esfahani, 2024b); (Adetunla et al., 2024). The prospective amalgamation of AI and VR can facilitate customized educational experiences, accommodating distinct learning styles (Analyti et al., 2024). Many educational institutions may find the cost of VR gear and software prohibitive (Analyti et al., 2024; Adetunla et al., 2024). Some pupils may lack access to essential technology, resulting in inequities in educational possibilities (Mahmoudi-Dehaki & Nasr-Esfahani, 2024). Successful deployment requires extensive training for educators to professionally utilize VR tools.

RQ3: How does VR as a digital learning innovation improve ESS skills?

VR is a breakthrough digital learning invention that markedly improves ESS skills in multiple areas (Table 1).

Table 3: VR as a digital learning innovation to improve ESS skills

Author	Country	Results	Conclusion
Jatmika et al. (2022)	Indonesia	A persuasive argument for the implementation of VR in English education, highlighting its capacity to revolutionize conventional pedagogical approaches and improve ESS involvement and comprehension.	The incorporation of VR into English instruction for ESS can revolutionize pedagogical methods, augment student involvement, and boost educational outcomes. It urges educators to adopt this technology and modify their approaches to accommodate the requirements of a contemporary classroom setting.
Wu & Hung, (2022)	Taiwan	VR can substantially improve grammatical and lexical proficiency in English-speaking performance among ESS	VR has the potential to boost some facets of English language acquisition, but it also highlights limitations in its efficacy concerning pronunciation, fluency, willingness to communicate, and learner autonomy.
(Chao & Chang, 2020)	Taiwan	VR technology can significantly improve spatial cognition. Education can markedly enhance pupils' comprehension, particularly for those encountering difficulties in conventional learning environments.	VR technology holds great potential as a transformative learning tool digital that improves spatial abilities captivates learners, and helps ESS deliver effective lessons.

(Demitriadou & Lanitis, 2019)	Cyprus	VR in the instruction of geometric solids can yield superior educational results in ESS relative to conventional approaches.	The use of VR and collaborative projects in education can substantially enhance students' digital skills, equipping them for future challenges in their academic and professional endeavors
(Hu et al., 2016)	China	Integrating VR with innovative cognition instruction not only augments students' creative capacities but also facilitates a more engaging and efficacious learning experience in ESS.	The integration of VR into creative thinking education effectively enhances ESS's creative capabilities and fosters a more engaging learning environment.

The review of five articles that look at VR as a new way to learn digital skills to improve ESS skills shows that VR as a way to learn can improve engagement, creativity, critical thinking, and skills in many areas that are crucial for developing 21st-century skills. There are many main advantages of VR as a digital learning innovation in elementary schools: increased engagement and motivation, development of creative and problem-solving skills, and improved language skills. This similar research by Erita et al. (2024) shows that VR enhances student engagement by providing interactive learning experiences that attract attention and encourage interest. Students exhibit elevated motivation levels during VR-based activities, resulting in enhanced learning results (Riyana & Setiawan, 2023). Immersive VR environments enable experiential learning, permitting students to intuitively understand abstract concepts (S.-J. Chen et al., 2024). VR-based 3D modeling markedly improves creative thinking and problem-solving skills, alleviating cognitive burden during the learning process (Chen et al., 2024). VR has demonstrated an improvement in English-speaking proficiency among primary pupils, especially in grammar and vocabulary usage (Sally Wu & Alan Hung, 2022). The immersive quality of VR promotes language skill practice in authentic circumstances, enhancing the propensity to speak.

Furthermore, VR has become an effective instrument for improving diverse skills in ESS. Studies demonstrate that VR can markedly enhance cognitive functions, creativity, and problem-solving capabilities, rendering it a beneficial component of instructional methodologies. Virtual reality can boost specific talents in educational support services: visual perceptual skills, creativity and problem-solving, and spatial abilities. VR applications, such as the Oculus Quest 2 exergames, have shown improvements in visual tracking and selective attention among students, thereby boosting their visual perceptual skills (Martín-Gutiérrez et al., 2017). A study *showed that both* VR and regular exercises made a big difference in improving visual pursuit skills. This suggests that VR can be useful in physical education settings (Demitriadou & Lanitis, 2019*).* Immersive VR settings enable practical experiences that enhance creative thinking and problem-solving abilities. Students involved in VR-based 3D modeling demonstrated improved creativity, encompassing imagination and curiosity (Chen et al., 2024). The alleviation of cognitive burden in immersive environments enhances students' concentration on problem-solving activities, thereby advancing their cognitive growth (Sally Wu & Alan Hung, 2022). VR technology has been beneficial in enhancing spatial abilities, especially in geometry. Interactive VR materials converted abstract 2D concepts into immersive 3D experiences, markedly improving students' spatial thinking and enthusiasm for learning (Chao & Chang, 2020). This method has been very advantageous for pupils with diminished arithmetic proficiency, demonstrating VR's capacity to accommodate varied educational requirements (Chao & Chang, 2020).

Conclusion

VR supports constructivist learning theory by promoting active participation and hands-on learning. This approach is essential for fostering a deep understanding of abstract topics, as students can manipulate virtual objects and explore environments that are inaccessible in other ways. VR is a promising digital learning innovation that can significantly enhance the skills and engagement of primary school students. This study effectively gathered and examined pertinent research findings, concluding that VR is an advantageous digital learning instrument in educational settings, especially for imparting essential abilities. The implications for using VR in education are significant, offering the opportunity to transform traditional learning environments and equip students with the skills needed for future success. However, careful consideration and strategic planning are essential to addressing the challenges and maximizing the benefits of this innovative technology. To fully realize the potential of VR as a digital learning innovation in education, we must address these limitations. Addressing these issues will be critical to the successful integration of VR into educational practice. This paper recommends conducting additional research to fully explore the potential of VR in education. It emphasizes the importance of continued investigation into how VR can be effectively integrated into educational environments to maximize its benefits for student learning.

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Author contribution

Ruth Rize Paas Megahati: Conceptualization; Methodology; Software. Data curation; Writing-Original draft preparation. Visualization; Investigation. Supervision. Software; Writing -Reviewing and Editing. All authors have read and agreed to the published version of the manuscript.

Declaration of generative AI in scientific writing

The authors acknowledge having used the Generative AI tool Quillbolt for grammar/language improvement only. The authors are solely responsible for all published content and has verified the accuracy and authenticity of the AI output.

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