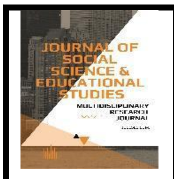

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A SYSTEMATIC REVIEW EXPLORING THE IMPACT OF AUGMENTED REALITY ON TEACHING MODULES IN VOCATIONAL EDUCATION.

Shahrul Amri Mohamad[1], Rozniza Zaharudin[2*], Hashim Fadzil Ariffin[3] & Sairah Abdullah[4]

[1,2] School of Educational Studies, Universiti Sains Malaysia, Malaysia
[3] Faculty of Hotel and Tourism Management, Universiti Teknologi MARA Pulau Pinang, Pulau Pinang
[4] Penang State Of Education Department, Pulau Pinang

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ABSTRACT

This study investigates how AR can be incorporated into educational modules, with an emphasis on its ability to change conventional teaching methods. Augmented reality improves the learning experience by developing immersive environments that encourage engagement with digital material, helping students connect theoretical understanding with real-world practice. This review focuses on how AR can enhance student participation, drive, and mastery of skills, especially in vocational and technical training. The literature review shows major obstacles in the implementation of AR, such as restricted infrastructure access, insufficient technical knowledge among teachers, and the lack of standardized frameworks for creating AR-based educational materials. Despite its proven benefits, these obstacles prevent a wider implementation of AR in education. The purpose of this review is to summarize the latest research on the effectiveness of AR in educational environments and to pinpoint areas that require attention for its successful integration. This review uses the PRISMA framework to systematically analyze 30 academic articles, investigating themes like the efficiency of AR in education and the obstacles in its implementation.In summary, upcoming studies need to concentrate on creating standardized frameworks and overcoming infrastructural limitations in order to fully utilize AR for improving educational practices in diverse learning settings.

Corresponding Author:

*Rozniza Zaharudin,
School of Educational Studies, Universiti Sains Malaysia, Malaysia
Email: roz@usm.my

INTRODUCTION

Augmented Reality (AR) has emerged as an innovative technology in contemporary education, significantly altering traditional pedagogical practices and enhancing the educational experience. By superimposing digital information onto physical environments, AR enables students to interact with content in a manner that is more engaging and immersive than previously possible. This technological advancement transforms abstract concepts into concrete experiences, allowing learners to visualize complex information, manipulate three-dimensional models, and engage with virtual entities in real time(Noguera et al., 2024). Such an approach not only increases student engagement but also fosters a deeper understanding of the subject matter. The integration of AR into educational curricula offers substantial potential for the development of personalized learning experiences, enabling educators to tailor content to align with the specific needs and learning modalities of individual students. One of the most significant advantages of AR in education is its capacity to bridge the gap between theoretical knowledge and practical application. For instance, in disciplines such as science, engineering, and vocational training, AR can simulate laboratory experiments, machine operations, or real-world scenarios that would otherwise be prohibitively expensive, hazardous, or logistically challenging to replicate. Izzul Syahmi, (2022) mentioned that this interactive approach ensures that students not only acquire theoretical principles but also comprehend their practical implications, leading to enhanced retention and application of knowledge. Despite the numerous benefits, integrating AR into educational systems presents significant challenges. Many institutions encounter obstacles such as limited access to AR-compatible hardware, insufficient technical expertise among educators, and inadequate infrastructure to support the seamless implementation of AR technologies. Furthermore, there often exists a discrepancy between existing pedagogical frameworks and the novel approaches that AR introduces. To maximize the potential of AR in education, it is imperative to develop comprehensive strategies that address these challenges and provide extensive training and resources for educators. Ultimately, while AR offers considerable opportunities for transforming education, overcoming these barriers will be crucial to its widespread adoption and efficacy.

LITERATURE REVIEW

The existing literature shows reliably that AR has a great advantage in enhancing student engagement, motivation, and the obtainment of specific skills, especially in vocational-technical education. The capacity of AR to generate immersive and interactive learning environments positions it as an excellent tool for bridging the gap between theoretical knowledge and its practical application. Traditional educational approaches often demonstrate a disparity between the information students acquire in the classroom and how they apply it in authentic real-world contexts. AR alleviates this disjunction by providing learners with virtual yet realistic simulated contexts wherein they can practice and hone their skills without the limitations imposed by physical resources or the hazards associated with actual operational scenarios (Vimala Devi, 2023). For example, within vocational education, students can engage with AR-enabled simulations of machinery or intricate systems, thereby acquiring practical experience in a secure and regulated environment. Although AR has yielded positive outcomes, the existing literature presents some obstacles to its Usage which are the shortcomings in designing effective AR-integrated teaching modules across various countries. Many researches support the claim that including AR may bring positive changes in learning outcomes, there are only a few that help teachers figure out how to design, alternatively, how to modify or evaluate AR-based instructional materials to make them suitable for all sorts of learners(Christopher Capul et al., 2024). The absence of uniformity in AR situated educational paradigm may pose a problem to teachers who may have no experience with this technology and its educational relevance. In addition, the use of AR may depend on various factors such as the topics being learned, the age of learners, and the situation of learning, hence the need for more research on how AR modules can be used in different contexts(Mohamad & Husnin, 2023). In addition, not much research has been carried out on the logistical and financial hindrances that still constrain the use of AR within the teaching processes. According to Baxter & Hainey (2024),many educational institutions seem set to face challenges in devising AR technologies across the board owing to a lack of appropriate installation aids or financial support, making easier their penetration. Aiming at such gaps requires a concerted perspective in identifying the strategies for AR adoption in order to make sure that this modern technology is well integrated and welcomed within different settings within the education sector. Further studies should advance beyond overemphasizing on the educational benefits of the AR and try to concentrate on the ways through which the barriers in the adoption and utilization of AR in education can be addressed.

OBJECTIVE

The objectives of this study are:

i. Analyze the role of AR in boosting learning results by bridging the gap between academic knowledge and hands-on experience in education.
ii. Determine the difficulties and limitations in the existing research on the creation and application of AR-integrated teaching modules, particularly for technical and vocational education.
iii. Investigate methods to address obstacles in infrastructure, finances, and technology for the broad implementation of AR in various educational settings.

METHODOLOGY

The process of conducting a systematic literature review is executed utilizing the PRISMA Framework, which necessitates a meticulous examination through three principal stages delineated in subsections Identification, Screening, and Eligibility. Upon the culmination of the data formulation, the subsection Data Abstraction and Analysis elucidates the review process grounded in the PRISMA Framework.

IDENTIFICATION

Three crucial steps are involved in the systematic review technique that is used to choose a set of relevant research for this investigation. The first step involves identifying keywords and investigating related, similar terms by using lexicons, thesaurus, encyclopedias, and previous academic studies. Once all relevant keywords had been identified, search strings were created to query both the Scopus and WoS databases, as table 1 shows. This research successfully collected 314 scholarly papers from the two databases for the systematic review project's first phase.

Table 1: Search String

Database	Search String
Scopus	TITLE-ABS-KEY ((("augmented reality" OR "AR" OR "mixed reality" OR "extended reality" OR "virtual environment") AND ("teaching module" OR "educational module" OR "instructional module" OR "learning module" OR "training module" OR "pedagogical module")))
WoS	(("augmented reality" OR "AR" OR "mixed reality" OR "extended reality" OR "virtual environment") AND ("teaching module" OR "educational module" OR "instructional module" OR "learning module" OR "training module" OR "pedagogical module"))

Source: September 2024(Scopus and Web Of Science)

SCREENING

During the initial screening phase, irrelevant articles were discarded, resulting in the removal of 55 papers at this preliminary stage. Accordingly, the ensuing screening phase involved the evaluation of 314 articles based on a predetermined set of inclusion and exclusion criteria devised by the researchers. The primary criterion employed was the nature of the literature, which prioritized empirical research articles as the principal source of actionable knowledge. Additionally, this criterion encompassed the exclusion of reviews, systematic reviews, meta-analyses, meta-syntheses, book series, individual books, and book chapters that did not align with the most recent research findings. It is crucial to underscore that this selection procedure was restricted to publications in the English language and focused on the five-year interval before the year 2020, extending to 2024. Ultimately, a total of 259 publications were excluded under these specific criteria.

ELIGIBILITY

In the third phase, referred to as the eligibility assessment, a total of 46 scholarly articles were compiled. The titles and essential content of these articles underwent a comprehensive evaluation to verify their compliance with the inclusion criteria and their alignment with the established research objectives. As a result, 16 articles were excluded from the assessment because they did not meet specific criteria, such as inconsequential titles, abstracts that were irrelevant to the review objective, and reports that fell outside the pertinent field. Ultimately, 30 articles remain available for analysis, as detailed in table 2.

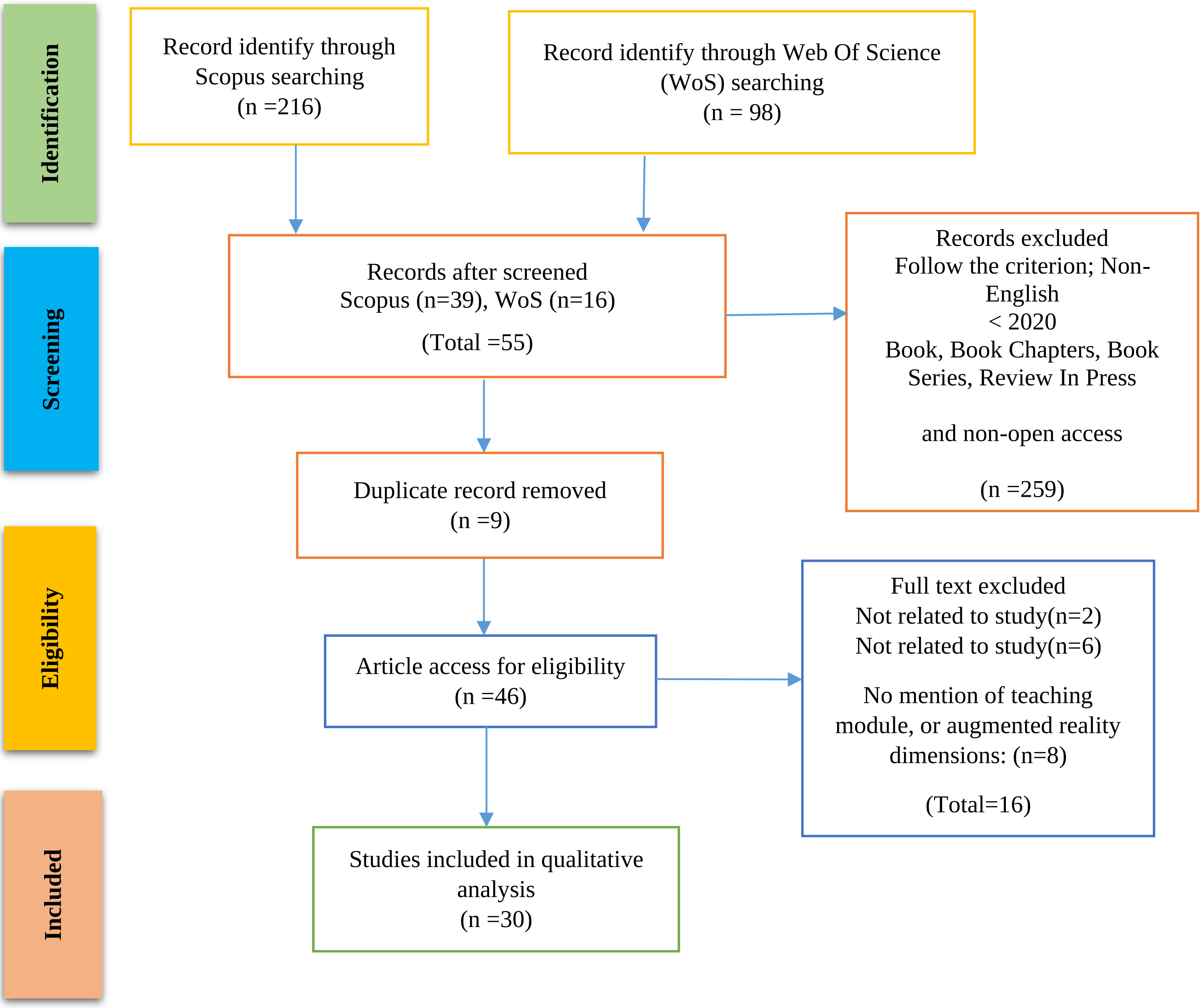
Table 2: The selection criterion of searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2020-2024	< 2020
Literature type	Journal (Article), Conference Proceedings	Book chapters, Book Series, Review
Publication Stage	Final	In Press

DATA ABSTRACTION AND ANALYSIS

This investigation employed a robust integrative analytical framework to synthesize diverse research paradigms, which included qualitative, quantitative, and mixed methodologies. The primary objective was to articulate relevant themes and subthemes concerning Augmented Reality and teaching module within the framework of vocational education pedagogy and learning environments. The data collection phase involved a thorough analysis of 30 scholarly publications, from which pertinent information was systematically extracted to address the central topics of the research. Three salient themes emerged: "Effectiveness of AR/VR in Enhancing Practical Skills and Safety in Vocational Education," "Challenges in Implementing AR/VR in Vocational Teacher Training," and " AR as a Tool for Enhancing Engagement and Motivation in Learning," which were subsequently discussed in detail alongside associated themes and concepts through collaborative dialogue among the authors. A comprehensive listing of the articles categorized by theme is documented in table 3, table 4 and table 5. A detailed and systematic record was diligently maintained throughout the data analysis phase to document methodologies, outcomes, inquiries, and any relevant specifics. The researchers also engaged in extensive deliberative discussions to resolve any discrepancies identified during the thematic development process, thereby ensuring the internal coherence of the established themes. The analysis underwent scrutiny by experts in the fields of Educational Technology (EdTech) and Technical and Vocational Education and Training (TVET) to verify domain validity, thus ensuring the relevance, clarity, and appropriateness of each sub-theme. The expert review component involved the incorporation of feedback and professional insights into the analysis, resulting in modifications intended to enhance the study's validity and reliability. The methodology of the PRISMA Framework is delineated in Figure 1:

Figure 1: Adapt from (Moher et al., 2009)



RESEARCH FINDINGS AND DISCUSSIONS

The use of Augmented Reality (AR) and Virtual Reality (VR) in vocational education has increasingly attracted scholarly and practical interest, particularly for its capacity to enhance teaching and learning. This review is organized around three central themes that have emerged from the current literature: (1) the effectiveness of AR/VR in enhancing practical skills and safety in vocational education; (2) the challenges faced in integrating these technologies into teacher training programs; and (3) the role of AR in promoting greater learner engagement and motivation. Each of these themes addresses key dimensions of AR/VR's application and its transformative potential for vocational education. The subsequent sections offer a critical analysis of these themes, drawing on key findings from the literature to identify both existing knowledge and gaps, as well as the broader implications for future practice and research.

Effectiveness of AR/VR in Enhancing Practical Skills and Safety in Vocational Education

Augmented Reality (AR) and Virtual Reality (VR) are progressively acknowledged as revolutionary instruments in vocational education, particularly due to their capacity to bridge the divide between abstract theoretical knowledge and pragmatic skill acquisition. These immersive technologies facilitate the creation of authentic, simulated environments wherein learners can engage in experiential learning devoid of the limitations or hazards associated with real-world contexts. Through interaction with virtual simulations, students are afforded the opportunity to practice their proficiency in operating intricate machinery, executing technical procedures, or maneuvering through perilous situations within a secure and regulated framework. This experiential learning paradigm enhances not only their practical competencies but also their self-efficacy in applying the skills acquired to real-world scenarios. The use of augmented reality and virtual reality technology in vocational education has a main appeal in that it enables the simulated environment and activities found in places of work to be put into practical use thus giving learners a context of the tasks that they are likely to perform when fully employed. An example is the use of Virtual Reality in training students in dangerous fields of construction or healthcare and also in therapy, where the students immerse into situations that would otherwise be too dangerous or expensive to props up in the real world. Similarly, if learners are engaging in hands-on exercises, AR can provide real-time support and feedback by projecting digital content into the physical scenery. The introduction of such technologies not only leads to improved learning outcomes but is also critical in supporting the development of safer training environments. AR and VR technology reduces the occurrence of mistakes and accidents, which improves the awareness of safety since learners are allowed to rehearse and perfect their skills in virtual worlds before the real world. It is expected that this combination of immersive technologies will changes the essence of vocational education, making it more efficient, interesting, and available for the students. Table 3 shows the summary of the findings.

Table 3: Overview of the findings

Theme	Author	Title	Findings
Effectiveness of AR/VR in Enhancing Practical Skills and Safety in Vocational Education	Al-Khiami & Jaeger, 2023	Safer Working at Heights: Exploring the Usability of Virtual Reality for Construction Safety Training among Blue-Collar Workers in Kuwait	The study examines the usability of a VR safety training module for Kuwaiti construction workers, finding that while it offers benefits, it requires more preparation and experience.
	Broyer et al., 2021	Using Virtual Reality to Demonstrate Glove Hygiene in Introductory Chemistry Laboratories	A collaboration between chemistry, computer science, and library faculty developed a VR instructional module on glove hygiene, providing a realistic and interactive laboratory experience for students with limited access to physical laboratories.
	Chichekian et al., 2022	Disrupted Lessons in Engineering Robotics: Pivoting Knowledge Transfer From Physical to Virtual Learning Environments	The study explores the influence of an Arduino microrobot activity on college students' interest in robotics, examining how it affects their understanding of microcomputing and programming, and the role of perceived knowledge transferability.
	Franco-Arellano et al., 2024	Updating the Foodbot Factory serious game with new interactive engaging features and enhanced educational content	Foodbot Factory, a serious game application, has been revised to incorporate immersive technologies and innovative features. The interdisciplinary team analyzed data from the original pilot study, literature, and stakeholder feedback to improve the app. The updated version, approved by 19 children, includes 19 learning objectives, augmented reality, new mini-games, aesthetic improvements, and accessibility features for users with cognitive and vision disabilities. The updated app has been found to be easy to use and fun.
	Gualtieri et al., 2024	A visual management and augmented-reality-based training module for the enhancement of short and long-term procedural knowledge retention in complex machinery setup	The study investigates the use of Augmented Reality and Visual Management in training operators in manufacturing, revealing that a VMAR-based training module is more effective than traditional methods in short- and long-term knowledge retention.

Theme	Author	Title	Findings
Effectiveness of AR/VR in Enhancing Practical Skills and Safety in Vocational Education	Guo et al., 2024	Shared Knowledge Distillation Network for Object Detection	The study proposes Shared Knowledge Distillation (Shared-KD) as a solution for optimizing 5G and 6G networks in autonomous vehicles, smart surveillance, and augmented reality, addressing feature disparities between teacher-student networks and combining it with other methods.
	Hakim & Cahyono, 2024	Developing MoAR-Integrated Printed Learning Modules to Improve Mathematical Problem-Solving Abilities in Geometry Learning	Developed an Augmented Reality (AR) interactive learning module for enhancing students' mathematical problem-solving abilities at Public Junior High School SMPN 2 Mantup, demonstrating practicality and effectiveness, and suggesting further research on specific topics.
	B. Han et al., 2023	HandDGCL: Two-hand 3D reconstruction based disturbing graph contrastive learning	Introduces a graph contrastive learning strategy for two-hand 3D reconstruction, enhancing the construction of realistic 3D hands from a single RGB image, particularly when two hands interact.
	Y. J. Han et al., 2024	Harnessing augmented reality technology for medical education - a virtual abdominal hysterectomy	AR-based teaching module for pelvic anatomy and hysterectomy steps, which will be tested on residents to assess its impact on self-perceived preparedness and training.
	Huang et al., 2023	Effectiveness of AR Board Game on Computational Thinking and Programming Skills for Elementary School Students	The study used augmented reality (AR) technology in the "Coding Ocean" board game to enhance elementary school students' computational thinking skills, demonstrating higher learning effectiveness, block-based programming achievement, and reduced cognitive load.
	Khazaie & Derakhshan, 2024	Extending embodied cognition through robot's augmented reality in English for medical purposes classroom.	A study found that robot-augmented reality in English for Medical Purposes classrooms significantly improved students' listening and reading skills, with participants showing a positive perception of the technology.
	Kurniawan et al., 2023	The effectiveness of using digital applications for diabetes mellitus with augmented reality models as learning media in pharmacy education	The study developed an Android-based mobile AR application for pharmacy students to learn about diabetes mellitus treatment. The application improved performance and learning outcomes, making it easier for students to study independently.

Challenges in Implementing AR/VR in Vocational Teacher Training

The use of Augmented Reality (AR) and Virtual Reality (VR) in vocational teacher training shows potential, but it is held back by various obstacles preventing widespread implementation. An important challenge is the insufficient technical knowledge of educators. Numerous educators, especially those in conventional or non-digital educational settings, lack knowledge of how AR/VR technologies work. Their lack of knowledge and skills hinders their ability to fully utilize these tools, reducing the potential for immersive learning experiences. Educators might find it challenging to set up, operate, and resolve issues with AR/VR systems due to their advanced technology compared to traditional teaching tools. As a result, the implementation of these technologies tends to be gradual and divided, as numerous educators stick to obsolete teaching techniques as they struggle to embrace modern, technology-focused teaching methods. Furthermore, it's common to have restricted access to the infrastructure required to execute AR/VR, particularly at educational institutions with low funding. A significant financial investment is needed for the AR/VR hardware, which includes high-performance PCs, headsets, and specialist software. Many vocational training facilities lack the funding to buy and maintain such equipment, especially in developing nations. In addition, there might not be enough technical support personnel even in cases where the technology is accessible, which puts more obstacles in the way of teachers who might need help using and incorporating AR/VR technologies into their lesson plans. Another important issue is the lack of emphasis on providing educators with adequate professional development and training. In educational settings with the necessary technology, numerous educators lack sufficient training to integrate AR/VR into their teaching methods. Professional growth programs are frequently restricted or absent, resulting in educators lacking the essential resources to adjust their instructional strategies to effectively integrate immersive technologies. This absence of assistance leads to AR/VR not being used to its full potential, despite acknowledging its ability to improve learning results. All of these issues make it more difficult for AR and VR to be widely used in vocational teacher preparation programs and, consequently, in vocational education overall. It is crucial to make investments in extensive teacher training programs, expand access to technology resources, and offer continuing support in order to remove these obstacles and make sure that educators are prepared to fully utilize AR and VR technologies. In order to successfully include AR/VR into vocational education, where technology holds great potential for enhancing both teaching and learning outcomes, it is imperative that these difficulties be resolved. The summary findings can be referred at the table 4.

Table 4: Overview Of summary findings

Theme	Author	Title	Findings
Challenges in Implementing AR/VR in Vocational Teacher Training	Lin et al., 2023	Developing an Integrated Teaching Module for the Topic of Smart Industry in the Museum	Taiwan's National Science and Technology Museum collaborated with universities and vocational high schools to create an integrated smart industry knowledge module, incorporating e-books, AR games, board games, and teaching aids, proving beneficial for science popularization and technological learning.
	Y. Liu et al., 2022	Real-Time Shadow Detection From Live Outdoor Videos for Augmented Reality	The article introduces a new framework for shadow detection in outdoor videos, utilizing Bayesian learning to identify emerging regions and correct erroneous shadow boundaries, outperforming existing algorithms and enhancing AR applications.
	Nadzri et al., 2023	The Effect of Using Augmented Reality Module in Learning Geometry on Mathematics Performance among Primary Students	A new framework for shadow detection in outdoor videos uses Bayesian learning to correct erroneous shadow boundaries. It outperforms state-of-the-art algorithms and improves average F-measure by 33.3%. The framework is particularly useful for AR applications and educational modules, improving student performance in Geometry.
	Ning et al., 2024	MT-RSL: A multitasking-oriented robot skill learning framework based on continuous dynamic movement primitives for improving efficiency and quality in robot-based intelligent operation	The paper introduces a multitasking-oriented robot skill-learning framework called MTRSL, which enhances efficiency and robustness in complex real-world environments. It includes sub-task segmentation, robot skill learning, and robot configuration optimization modules. Experimental results show it outperforms existing methods.
	Nordin et al., 2020	Mobile augmented reality using 3d ruler in a robotic educational module to promote stem learning	The research aims to design an AR-based application that visualizes the distance between two robots, supporting learning through a game-based module, using the Agile model, resulting in increased student interest in robotic educational games.

Theme	Author	Title	Findings
Challenges in Implementing AR/VR in Vocational Teacher Training	Obayemi et al., 2024	A needs assessment for simulation in African surgical education	A study in eight low-middle-income countries found a need for comprehensive surgical training, especially in psychomotor skills for intracorporeal suturing and laparoscopic camera driving. A simulation curriculum could familiarize staff and trainees with laparoscopic techniques, overcoming barriers.
	Piñal & Arguelles, 2024	Mixed reality and digital twins for astronaut training	This study develops four scenarios inspired by NASA and ESA astronaut training programs, using mixed reality, practical scenarios, and a spacecraft launch. Participants interact with digital twins, generating data for analysis against the ISS dataset and telemetry.
	Qin et al., 2021	Exploring Chemistry with Wireless, PC-Less Portable Virtual Reality Laboratories	Researchers at Harvard University used a portable VR lab to enhance spatial recognition and engagement in undergraduate chemistry classes. The eco-friendly, portable lab was used to explore protein and drug compound shapes, highlighting potential future directions.
	Ramadhan et al., 2024	User-Friendly Evaluation of Three-Dimensional Visualization of Atomic Models on Mobile Teaching Module Application: PyLo-AR	The study assesses the usability of the Marker-Based Augmented Reality (M-AR) mobile app, PyLo-AR, for high school students, evaluating its attractiveness, efficiency, accuracy, clarity, and novelty.
	Ramli et al., 2021	Microorganisms: Integrating Augmented Reality and Gamification in a Learning Tool	Microorganisms is a primary school learning application that uses augmented reality and gamification to enhance students' understanding of microorganisms, with a user satisfaction rating of 4.6 out of 5.

AR as a Tool for Enhancing Engagement and Motivation in Learning

AR is now widely used to improve student engagement and motivation, presenting significant opportunities for transformation in educational environments. In contrast to traditional learning approaches, AR encourages active engagement through interactive, real-time experiences instead of passive information reception. The transition from passive to active learning occurs by using AR to superimpose digital content onto the real world, enabling students to engage with virtual elements and gain a clearer understanding of challenging ideas. For example, AR can make abstract topics like anatomy, mechanics, and engineering more interactive, allowing students to interact with 3D models, simulate procedures, and participate in practical activities that are challenging to recreate in a traditional classroom. The learner and the content become more deeply connected as a result of this interaction, which boosts motivation and prolongs engagement. AR's immersive qualities are especially useful in vocational education, where practical skills are crucial. It gives students lifelike replicas of actual settings so they can practice skills in a safe atmosphere. This boosts students' confidence and competence by enabling them to gain proficiency in tasks like operating machines, carrying out technical processes, or troubleshooting systems.

Moreover, AR's ability to adjust to various learning styles enables it to be a flexible instrument that can accommodate students' varied requirements. AR guarantees that students of all learning styles can interact with the material in ways that align with their preferred way of learning, whether it be through visual, auditory, or kinesthetic means. Research has shown that this active, engaging method results in enhanced learning results, improved information recall, and increased enthusiasm for further vocational training. The summary of the findings can be found in table 5.

Table 5: Overview of summary findings

Theme	Author	Title	Findings
AR as a Tool for Enhancing Engagement and Motivation in Learning	Razak & Senan, 2022	Mobile Learning for Manually Coded Malay Sign Language Using Augmented Reality	KTBM AR is a mobile learning solution for Malay Sign Language, incorporating AR for interactive learning and achieving a 94% acceptable System Usability Scale.
	Shen et al., 2024	Smartphone-Based Virtual and Augmented Reality Implicit Association Training (VARIAT) for Reducing Implicit Biases Toward Patients Among Health Care Providers: App Development and Pilot Testing	The study evaluated VARIAT, a mobile app developed by an interdisciplinary team, to reduce implicit biases among Medicaid providers. The app, which focused on race, socioeconomic status, and sexual orientation, showed positive satisfaction and efficacy.
	Siu et al., 2022	A framework for synthetic image generation and augmentation for improving automatic sewer pipe defect detection	The paper presents a framework for synthesizing data for sewer pipe defect detection, enhancing accuracy through 3D modeling and simulation, and utilizing style transfer and contrastive learning, thereby reducing data collection and annotation burden.
	Spinczyk et al., 2024	Towards overcoming barriers to the clinical deployment of mixed reality image-guided navigation systems supporting percutaneous ablation of liver focal lesions	A study proposes a training module for minimally invasive liver tumor treatment using image-guided navigation systems and mixed reality technology, improving skills in diagnosis, planning, execution stages, and needle inserting, and allowing for new hologram creation.
	Srinivasa et al., 2021	Virtual reality and its role in improving student knowledge, self-efficacy, and attitude in the materials testing laboratory	The study at Texas A&M University found that using virtual reality in mechanical engineering lab classes improved academic achievement, engagement, attitudes, and self-efficacy, particularly among female students, suggesting the integration of these technologies in manufacturing training programs.
	X. Liu et al., 2024	Integrating augmented reality technology in education: vector personal computer augmented reality	During the COVID-19 pandemic, educators in Malaysia used augmented reality (AR) technology, specifically VPCAR, to teach complex vector concepts. A 3-dimensional learning module was developed, and a survey showed easy adaptation, suggesting VPCAR can support online teaching.
	Vassigh et al., 2020	Teaching Building Sciences in Immersive Environments: A Prototype Design, Implementation, and Assessment	"Skope" is an immersive learning environment for architecture, engineering, and construction students, utilizing augmented and virtual reality to simulate sustainable building construction, enhancing motivation and collaborative learning.

Theme	Author	Title	Findings
	Wang et al., (2023)	DeepAdaIn-Net: Deep Adaptive Device-Edge Collaborative Inference for Augmented Reality	The DeepAdaIn-Net is a deep adaptive inference network for real-time device-edge collaborative object inference, reducing feature transmission volume and ensuring high feature-fitting accuracy, outperforming conventional methods in COCO2017 and emergency fire datasets.

CONCLUSION AND RECOMMENDATION

This comprehensive literature review explores the incorporation of Augmented Reality (AR) in educational modules, emphasizing AR's considerable capacity to improve teaching practices. Through linking theoretical teaching with practical use, AR offers learners immersive and interactive experiences that boost engagement, motivation, and skill growth, especially in vocational and technical education environments. Although there are significant advantages, there are still obstacles to integrating AR smoothly into educational programs.

The lack of standardized frameworks for creating and executing AR-integrated teaching modules is an important drawback noted in this assessment, making it difficult for teachers unfamiliar with the technology to fully utilize its potential. Significant obstacles to its broad implementation in educational institutions include insufficient understanding of technology, restricted access to AR-compatible infrastructure, and financial limitations. The evaluation also revealed an absence of long-term research assessing AR's ongoing influence on learning outcomes in a range of educational contexts.

Future studies should focus on creating unified structures for implementing AR, offering educators clear directions for designing, adjusting, and assessing instructional materials based on AR. Furthermore, research should prioritize addressing the constraints of funding and infrastructure through the exploration of affordable solutions and technologies that can be easily expanded. Broadening the research focus to evaluate how AR influences teaching and learning practices in different educational settings and among various learner groups will be important for maximizing its effectiveness in the long run.

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