IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received 20 January 2024, accepted 1 March 2024, date of publication 4 March 2024, date of current version 12 March 2024.

Digital Object Identifier 10.1109/ACCESS.2024.3373541

RESEARCH ARTICLE

The Impact of Immersive Learning on Teacher Effectiveness: A Systematic Study

DIPIMA BURAGOHAIN[1], (Senior Member, IEEE), CHAOQUN DENG[1], ABHISHEK SHARMA[2], (Senior Member, IEEE), AND SUSHANK CHAUDHARY[3], (Senior Member, IEEE)

[1]School of Foreign Languages, Guangdong University of Petrochemical Technology, Maoming, Guangdong 525000, China
[2]School of Electronics Technology, Guru Nanak Dev University, Amritsar 143005, India
[3]School of Computer, Guangdong University of Petrochemical Technology, Maoming, Guangdong 525000, China

Corresponding author: Sushank Chaudhary (sushankchaudhary@gmail.com)

This work was supported by the Guangdong University of Petrochemical Technology, China.

ABSTRACT Immersive learning, or experiential learning, involves placing teachers in realistic scenarios where they can practice their skills and receive feedback in a safe, controlled environment. This study conducts systematic research to investigate the impact of immersive learning on teacher effectiveness. The research included 16 articles from electronic databases including IEEE, ERIC, and Google Scholar that met the inclusion criteria based on PRISMA guidelines. Evaluation of the selected articles was based on the CASP checklist. The findings suggest that immersive learning has a positive impact on teacher effectiveness, improving teachers' content knowledge, pedagogical skills, and confidence in their abilities to handle real-life situations in the classroom. The study highlights the need for further research in this area, particularly regarding the long-term impact of immersive learning on teacher effectiveness. The use of immersive learning in teacher education can enhance the quality of teacher preparation programs and provide professional development opportunities for practicing teachers.

INDEX TERMS Experiential learning, immersive learning, teacher education, teacher effectiveness, systematic review.

I. INTRODUCTION

Immersive learning, also known as experiential learning, is a teaching approach that involves placing teachers in realistic scenarios where they can practice their skills and receive feedback in a safe, controlled environment. It is an approach to education that involves creating a fully immersive and interactive learning environment. This approach is becoming increasingly popular as more and more educators recognize the benefits of experiential learning and the need to engage students in a more meaningful way [1]. In an immersive learning environment, students are placed in a simulated or real-world environment that is designed to replicate the experiences they would have in a real-life situation. For example, students might be placed in a virtual reality environment where they can practice a particular skill or complete a specific task, or they might be taken on a field trip to a relevant location to experience the subject matter firsthand. The goal of immersive learning is to create a highly engaging and interactive learning experience that allows students to connect with the subject matter on a deeper level [2]. By immersing students in a realistic and relevant environment, they are better able to understand and retain the information being presented to them. One of the key benefits of immersive learning is that it allows students to develop practical skills that are directly applicable to their future careers or life experiences [3]. For example, a nursing student might use a simulated patient environment to practice their clinical skills in a safe and controlled environment, or a business student might use a virtual reality environment to practice negotiation tactics. Another benefit of immersive learning is that it can be highly adaptable to different learning styles and abilities [4]. For example, students who struggle with traditional classroom learning might benefit from the hands-on and experiential nature of immersive learning. In other words, immersive learning is a

The associate editor coordinating the review of this manuscript and approving it for publication was Giacinto Barresi.

highly effective approach to education that can help students develop practical skills and gain a deeper understanding of the subject matter. As technology continues to advance, more and more immersive learning environments are expected to be experienced as tools helping students learn in new and innovative ways.

In terms of the current educational context, the COVID19 pandemic has impacted the education sector globally, resulting in revolutionary transformations on pedagogical practices. As the pandemic has forced many schools and universities to close their physical doors, the use of digital technologies has become one of the many trends of 'new normal' that institutions and educators have adopted/adapted [5], [6]. Immersive learning has become an excellent way for students to continue their education without risking their health (through remote learning) and for teachers to maintain learner engagement and motivation. This can further help teachers enhance their teaching effectiveness. By providing interactive and customized learning experiences, immersive learning can help teachers to cater to the unique learning styles and preferences of each student [7]. Teachers can use real-time feedback to assess student progress and provide timely interventions to help students who may be struggling. Teachers can use immersive learning to create group projects and simulations that require students to work together and solve problems as a team [8], [9]. Moreover, teachers can use immersive learning to develop new skills and techniques, and to gain experience in new teaching methods that they can then apply in the classroom [10], [11]. However, adapting to the latest digital technologies is not so easy for educators. One of the primary challenges when implementing immersive technologies is technical issues such as limited technology access [12], [13] and inadequate technical expertise, training, and support [11], [14], [15]. In the light of these concerns, the current study aims to investigate the impact of immersive learning on teacher effectiveness. It conducts a systematic review of available and related literature to answer the following research questions (RQs):

- **RQ1:** How does immersive learning impact teacher effectiveness?
- **RQ2:** What is the role of immersive technologies in future teaching practices?

II. METHODS

This study is a systematic review of existing literature on immersive learning in teacher education. A total of 16 relevant articles were identified through searches of electronic databases including IEEE, ERIC, and Google Scholar. The study used PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to screen the selected articles based on inclusion and exclusion criteria. PRISMA is a set of guidelines for reporting systematic reviews and meta-analyses, which assists authors with appropriate reporting of different knowledge synthesis methods (such as systematic reviews, scoping reviews, and review protocols) and ensures that all aspects of this type of research are accurately and transparently reported [16]. The current study further used the CASP (Critical Appraisal Skills Program) checklist to conduct quality assessment of the selected articles based on a predefined set of criteria. CASP tool is designed to help appraise different types of research studies, including randomized controlled trials, systematic reviews, and qualitative studies [17].

To conduct a systematic review, the current study screened and selected 16 research articles from electronic databases of IEEE, ERIC, and Google Scholar published between 2019 and 2022. IEEE (Institute of Electrical and Electronics Engineers), ERIC (Education Resources Information Center), and Google Scholar are popular search engines used for finding academic articles and other scholarly resources. Sponsored by the U.S. Department of Education, ERIC is a powerful resource for researchers, educators, and policymakers who are interested in finding high-quality and peer-reviewed research on a variety of education-related topics. The database can be searched by keyword, author, publication type, and other criteria, and it provides full-text access to many articles and reports extensive and easily accessible database of scholarly literature in a variety of fields. IEEE accommodates free (limited) and subscription-based publications dedicated to various disciplines across electrical, electronics, and computer engineering fields. Google Scholar provides access to academic articles, theses, books, conference papers, and other scholarly resources from a variety of sources. It is particularly useful for finding articles that may not be included in other academic databases, as well as for finding articles that are freely available online. The selection involved three phases of preparation based on PRISMA guidelines including identification, screening, and inclusion. The selected articles were then evaluated using the CASP checklist. Figure 1 below briefly describes the research design of the study.

Findings of the study are explained in the Results section.

III. RESULTS

The study included selection and evaluation of 16 articles based on PRISMA guidelines and the CASP checklist. The first phase, Identification, included choosing IEEE, ERIC, and Google Scholar as the primary databases for collecting the relevant research articles. The identification phase involved searching and selecting relevant articles based on keyword search in article titles and metadata, as shown in Figure 2 below. The study identified 58 research items collected from the databases of IEEE, ERIC, and Google Scholar.

The second phase, Screening, included screening of these articles. The study selected 20 articles out of the total screened publications, which was based on a set of criteria demonstrated in Figure 3 below.

For choosing publications, the study selected the timespan of the pandemic outbreak (2019-22) during which the dynamics of academic practices drastically changed, paving the way for more technology innovations in

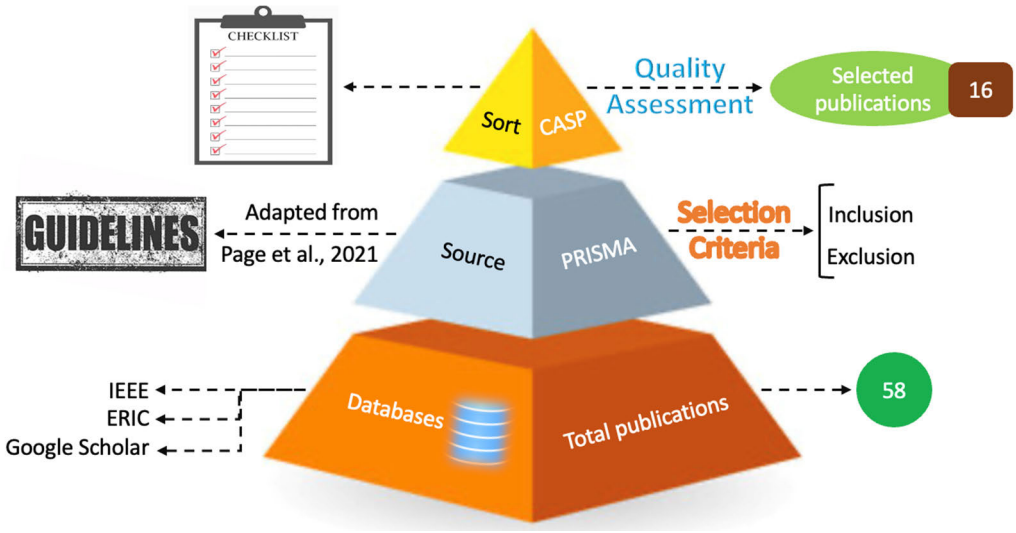

FIGURE 1. Research design.

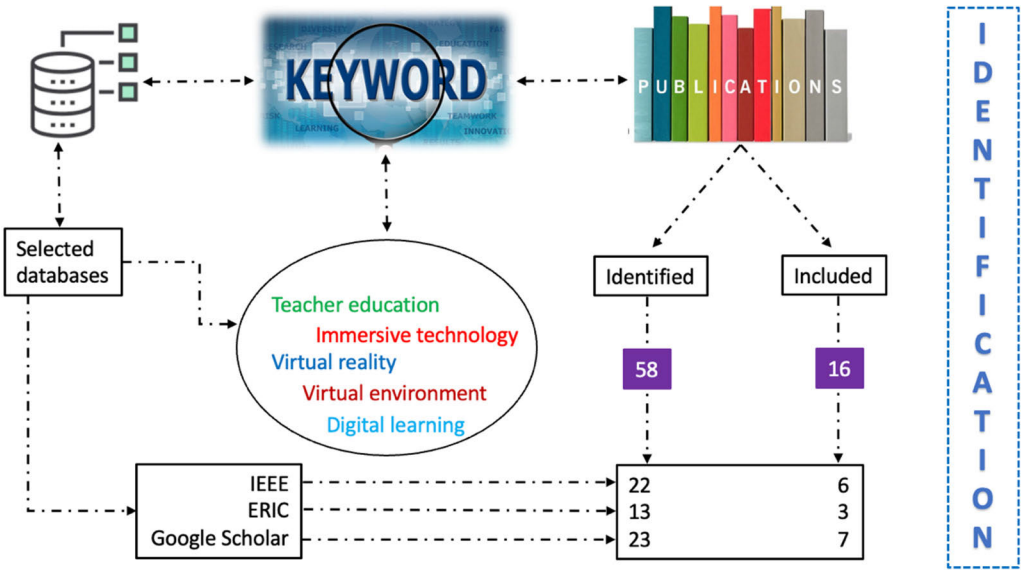

FIGURE 2. Identification phase.

education [18], [19]. During and after the COVID19 pandemic, schools and universities worldwide turned to online learning platforms to provide continuity in education, thereby resulting in a surge in the use of virtual classrooms, video conferencing tools, and other online learning platforms. Blended modes of teaching and learning practices leveraged the benefits of technology to provide flexible and personalized learning experiences – a familiar feature in immersive learning environments [20]. Right from providing teaching and learning platforms to accessibility of digital resources (online databases, educational apps, etc.), collaboration tools (shared documents, online discussion forums, etc.), and even assessment tools (e.g., online testing platforms), digital technologies have been implemented for the optimized teaching and learning functions [21], [22]. In other words, technology innovations have been more instrumental in pedagogical mechanisms than ever. In the light of this, the current study set the inclusion and exclusion criteria (Figure 3 above) to select the relevant literature of the selected timespan discussing the role of immersive learning environments in teacher effectiveness. To avoid any issues related to translation, it chose the English language as one of the criteria to select the articles, which were collected from a nationwide study.

The third phase, Inclusion, involved selection of eligible articles (using PRISMA guidelines) and their reevaluation

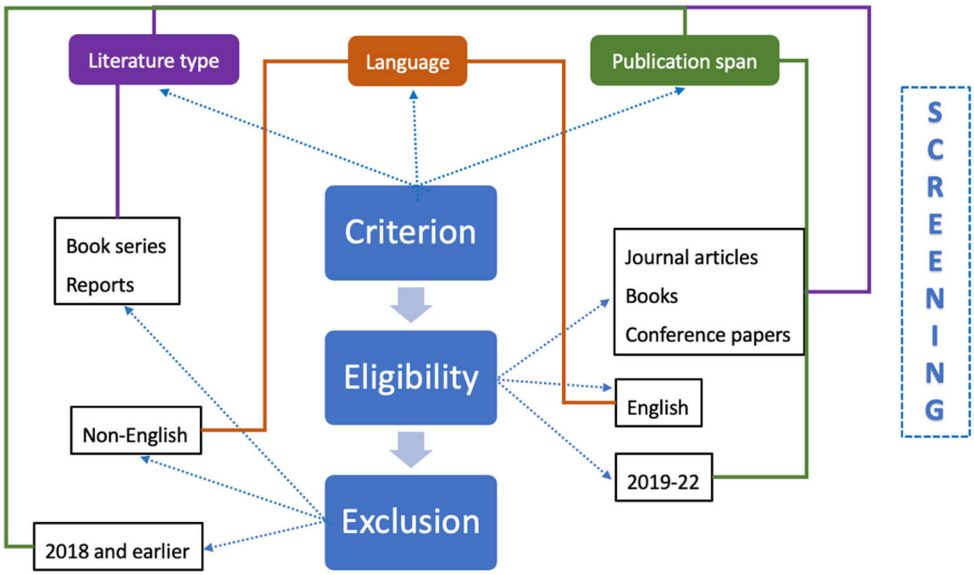

FIGURE 3. Screening phase.

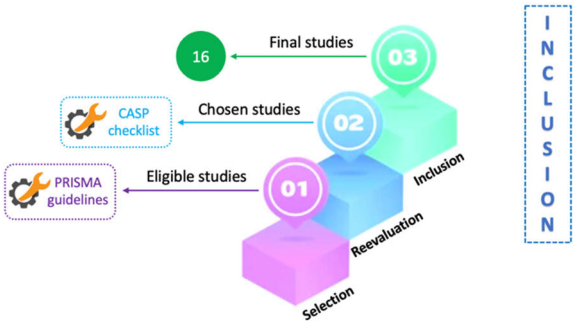

FIGURE 4. Inclusion phase.

TABLE 1. CASP checklist adapted from [17].

Was there a clear goal of the research with its highlights?
Is the research method/design appropriate for addressing the research goal?
Are the study's theoretical considerations clear, consistent, and conceptually coherent?
Was the participant selection strategy appropriate to the research goal?
Did the data collection address the research issue?
Has the relationship between researcher and participants been adequately considered?
Have ethical issues been taken into consideration?
Was the data analysis sufficiently rigorous?
Is there a clear statement of research findings?
How valuable is the research?

(using the CASP checklist). During this phase, 20 articles selected from the previous phase were evaluated for quality appraisal. The final inclusion of study featured 16 articles, as shown in Figure 4 below.

The study used the selection process adapted from [23]. Details of the selection process are described in Figure 5 below.

The study further used CASP checklist to appraise the quality of the selected articles. The CASP tool contains ten questions focusing on different methodological aspects of a research work. The study used the CASP checklist with questions adapted from [17]. The modified CASP checklist is described in Table 1.

The study used the CASP tool, which is an efficient indicator of transparency in research practice and reporting standards [17]. Based on the results, the 16 selected articles were divided under the categories of participant count, research scope, and design type. Articles were divided into two broader groups: with and without participants. Other demarcations are listed as follows: a) scope of the study (related to teachers and/or students) and b) research design type (identified as quasi-experimental, mixed methods, case study, qualitative, quantitative, randomized controlled trial, survey, literature review, and/or systematic review). These categories are demonstrated in Figure 6 below.

It is important to note that these distinctions are developed to further provide clarity on the research findings of the selected studies. Findings of the study are described in Tables 2-6 below.

As shown in the tables above, studies pertaining to teachers' perspectives focused on teacher beliefs, practices, readiness, and preparation to participate in immersive teaching-learning environments. These studies reported that integrating immersive teaching setups helped improve their various pedagogical skills including lesson planning and implementation, teaching approach, and student engagement and management, such as dealing with learners' challenging behaviors. However, the studies have also identified and highlighted the relevance of teacher training, their challenges

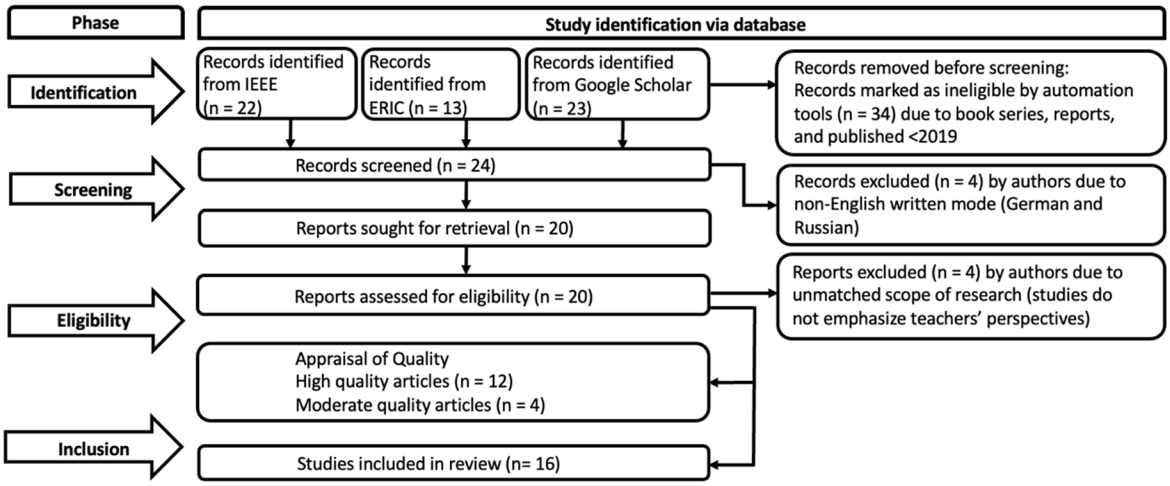

FIGURE 5. Selection process adapted from [23].

TABLE 2. Study findings with participants (teachers' perspectives).

1st Author & Year	Teachers' perspectives	Setting	Outcome	Mean CASP (%)
Heaysman (2021)	Self-regulated learning beliefs and practices	Israel	Improvement in teachers' self-regulated learning beliefs, practices, lesson planning, and implementation skills	78.33
Dengel (2021)	Immersive classrooms	Germany	Highlighted the importance of teacher training and support in facilitating immersive learning environments	79.17
Chen (2022)	Management of students' challenging behaviors	Taiwan	Improvement in teachers' knowledge, skills, and confidence in dealing with learners' challenging behaviors	80
Mills (2019)	Immersive virtual environment beliefs and practices	US	Significant impact on teacher beliefs but not on their immersive pedagogical practices	78.89
Abbitt (2021)	Technology integration course	US	Positive impact on technology integration course; highlighted challenges and barriers to integrating technologies in curriculum	77.22
Gómez-García (2021)	Mobile learning in primary education	Spain	Highlighted the potential of augmented reality as a mobile learning tool to enhance primary teaching and learning experience	77.5

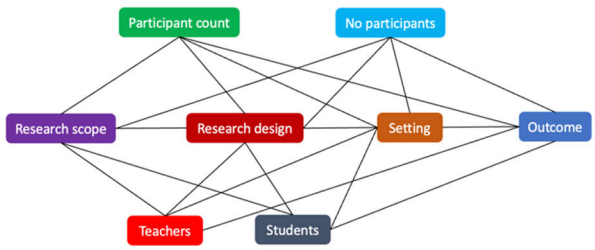

FIGURE 6. Study categorization.

and barriers in an immersive classroom, and technical factors affecting their preparedness and learner disengagement. In terms of studies addressing students' perspectives, aspects like learners' learning outcomes, engagement, emotions, motivation, attitudes, and performance in immersive learning environments were highlighted. These findings suggest that immersive learning has a positive impact on teacher effectiveness. Specifically, immersive learning has been shown to improve teachers' content knowledge, pedagogical skills, and confidence in their abilities. Additionally, teachers who participated in immersive learning reported feeling better prepared to handle real-life situations in the classroom.

IV. DISCUSSION

The findings of this study have important implications for teacher education, responding to the research questions addressing the relevance of immersive learning in teacher effectiveness (RQ1) and the role of immersive technologies in future teaching practices (RQ2). Immersive learning can be a useful tool in improving teacher education, teacher preparation, and teacher effectiveness in several ways some of which are discussed in this section. First, immersive learning technologies, such as virtual and augmented reality, can provide an engaging and interactive learning experience for teachers. This can make the learning process more

TABLE 3. Study findings with participants (students' perspectives).

1st Author & Year	Students' perspectives	Setting	Outcome	Mean CASP (%)
Shen (2022)	Geography students' emotions and motivation	China	Higher levels of learners' positive emotions and motivation	81.25
Maheshwari (2020)	STEM education	India	Improvement in students' learning outcomes and attitudes towards STEM subjects	80.56
Miller (2021)	Performance and grades for university learners	US	Improvement in learner performance and grades with higher level of engagement	82.5

TABLE 4. Study findings without participants (teachers' perspectives).

1st Author & Year	Teachers' perspectives	Setting	Outcome	Mean CASP (%)
Stojšić (2019)	Teacher readiness	Serbia	Highlighted teachers' challenges and barriers about learner distraction and disengagement	76.67
	Immersive teaching		Highlighted factors including technical aspects, pedagogical approach, and student engagement for virtual reality implementation	76.67
Lane (2022)	Teacher education and its preparation	US	Highlighted careful planning and consideration of various factors including technical support, teaching approaches, and student engagement	78.33
Hein (2021)	Foreign language learning with immersive technologies	Generic	Focused on the effectiveness of various immersive technologies in supporting foreign language learning	82.22
Billingsley (2019)	Teacher education using immersive technology	Generic	Highlighted potentials to enhance teacher education along with challenges and limitations of using immersive virtual reality	77.5
Hager (2020)	Teacher preparation programs	Generic	Highlighted effective technology integration into teacher preparation programs to improve teacher preparation	80

TABLE 5. Study findings without participants (students' perspectives).

1st Author & Year	Students' perspectives	Setting	Outcome	Mean CASP (%)
Marks (2022)	Purpose-designed higher education laboratory setting	Australia	Highlighted its effect in enhancing students' engagement and understanding the course content	81.11

TABLE 6. Details of research design of the selected studies.

Research design	1st Author & Year
Quasi-experimental	Chen (2022); Shen (2022); Heaysman (2021); Maheshwari (2020)
Case study	Lane (2022); Dengel (2021); Stojšić (2019)
Mixed methods	Marks (2022); Mills (2019)
Randomized controlled trial	Miller (2021)
Qualitative	Abbitt (2021)
Quantitative	Gómez-García (2021)
Survey	Stojšić (2019)
Literature review	Lane (2022); Hager (2020); Stojšić (2019)
Systematic review	Hein (2021); Billingsley (2019)

enjoyable and memorable, leading to better retention of information and skills. An immersive virtual reality-based learning environment can not only improve student engagement and motivation but also promote positive emotions, and thus contributing to teacher effectiveness with more interactive learning experience [24]. Moreover, studies [25], [26], [27] reported significant improvements in students' learning outcomes in immersive classrooms with virtual and augmented reality. In terms of teachers, training programs in immersive virtual reality can be effective in developing and improving teachers' knowledge and management skills in dealing with students' challenging behaviors [28].

Immersive learning can simulate a variety of real-world scenarios, which can help teachers develop important skills and competencies. For example, teachers can practice classroom management techniques in a virtual classroom or learn how to respond to challenging situations that may arise in the classroom. They can design appropriate educational

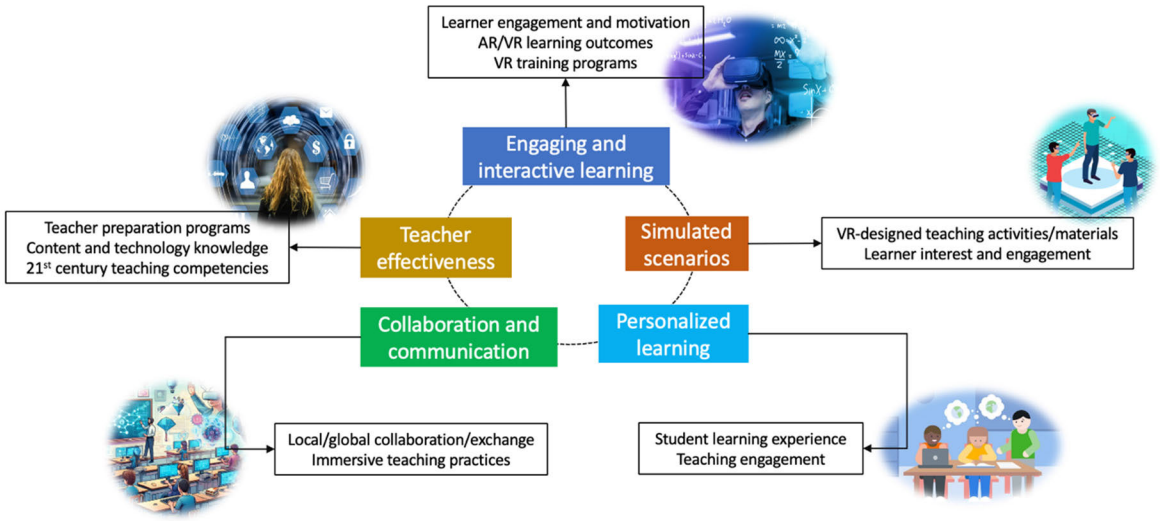

FIGURE 7. Summarized findings.

activities and materials through virtual reality-simulated scenarios [29]. Moreover, simulated scenarios can improve learner interest and engagement in different subjects [26].

Immersive learning can be customized to meet the individual learning needs of teachers. Teachers can work at their own pace, review content as needed, and receive immediate feedback on their performance. Their willingness to integrate technology into teaching and utilize various technology tools like mobile devices can help them improve their technical knowledge and skills, which can further enhance student engagement and learning experience [30]. Therefore, it is important that teachers develop adaptiveness to use immersive technology for improving their own teaching abilities and increasing their engagement with the learning process [31]. While having positive impact on students' learning outcomes, the study also reported that immersive technology helped teachers develop practical teaching skills, such as lesson planning and classroom management, and allowed them to experiment with different teaching strategies in a safe and controlled environment.

Immersive learning can provide opportunities for teachers to collaborate and communicate with other teachers, both locally and globally [32]. This can help build a professional learning network, share best practices, and develop new ideas for improving teaching and learning. Moreover, teachers receiving immersive classroom instruction can demonstrate effective teaching practices, higher levels of self-efficacy, and more positive attitudes toward using technology in the classroom than those receiving traditional classroom instruction [33].

Immersive learning can be used as an effective tool to improve the quality of teacher preparation programs. Studies reported that immersive technology can be an effective tool in teacher education including preservice and in-service teacher training, professional development, and classroom instruction, which can improve teaching practices, increase engagement and motivation, and enhance learning outcomes [34], [35]. Moreover, immersive learning can be used to provide professional development opportunities for practicing teachers. Technology-integrated teacher preparation programs can provide teachers with opportunities for authentic and meaningful learning experiences, improve their content knowledge and pedagogical skills, and increase their confidence in using technology in teaching practices [36]. While providing insights on these aspects discussed by the selected articles, the current study also highlighted the need for further research in this area, particularly regarding the long-term impact of immersive learning on teacher effectiveness. Studies have reported the need for development of simulation-based programs for teacher professional development [37], analysis of the practical challenges of immersive technology integration in everyday classrooms [25], design of appropriate educational activities and materials for immersive learning environments [29], provision of adequate technical support and training to teachers to overcome barriers affecting technology-integrated teaching process [30], and integration of immersive technology into teacher preparation programs that can help teachers develop necessary skills and competencies for effective teaching in the 21st century [31]. While focusing on these areas, it is equally important to explore and investigate barriers and challenges impacting technology integration into the teaching and learning process. Figure 7 below summarizes these findings.

In the light of this discussion, it is appropriate to comment that immersive learning plays a crucial role in impacting teacher effectiveness in the current pedagogical practices (RQ1) while highlighting the immersive technologies and tools to be integrated and used and various other aspects to consider in the upcoming teaching processes (RQ2). Tables 7 and 8 below summarize syntheses of findings of

TABLE 7. Synthesized findings for RQ1.

1st Author and Year	Relevance of immersive learning in teacher effectiveness
Heaysman (2021)	Simulation-based programs for effectively increasing teachers' professional development, self-efficacy, and self-regulation in teaching practices
Abbitt (2021)	Virtual reality-integrated teacher preparation programs for improving teachers' teaching practices, self-efficacy beliefs, and attitudes towards immersive classrooms
Billingsley (2019)	Immersive technology integration in teacher education programs for improving teaching practices, engagement, and learning outcomes
Chen (2022)	Immersive virtual reality training for improving teachers' knowledge, skills, and confidence in managing students' challenging behaviors
Stojšić (2019)	Adequate technical support and training to influence teachers' use of mobile devices integrated with immersive technology in teaching processes
Lane (2022)	Immersive technology-based teacher preparation programs to improve teachers' perceptions and skills to meet the challenges of modern-day teaching
Mills (2019)	Immersive virtual environments for improving teachers' beliefs about and practices in technology-integrated classrooms
Gómez-García (2022)	Augmented reality-integrated teacher training for improving teaching practices through mobile learning
Hager (2020)	Technology-based teacher preparation programs for enhancing teachers' professional development and teaching practices

TABLE 8. Synthesized findings for RQ2.

1st Author and Year	Role of immersive technologies in future teaching practices
Shen (2022)	Immersive virtual reality-based classrooms for more engaging and interactive learning experience
Dengel (2021)	Cost and availability of technology, teacher training, and curriculum alignment
Maheshwari (2020)	Immersive teaching content for enhancing students' learning outcomes and interest in the subjects
Hein (2021)	Immersive technology integration in language learning curricula with other instructional methods to improve students' language proficiency
Miller (2021)	Immersive teaching practices to enhance student engagement and learning outcomes
Marks (2022)	Purpose-designed virtual reality-integrated curricula to enhance student engagement, learning outcomes, and satisfaction

the selected studies in relation to the research questions. As apparent in the findings of the selected studies, immersive learning is instrumental in enhancing teacher effectiveness. Studies (listed in Table 7) have reported the need for immersive technology integration in teacher preparation programs, which can improve teaching practices and professional development of educators. Such programs can provide meaningful insights on the relevance of immersive technologies in education processes and how teachers can utilize their knowledge not only for improving students' learning outcomes but also for their own professional enhancement. It is important that teachers are trained and prepared to understand and use technical knowledge and skills of immersive technologies, which can further be applied in managing students' challenging behaviors, engagement, and satisfaction through an interactive learning experience.

In terms of the role of immersive technologies in future teaching practices, studies (listed in Table 8) have reported the significance of immersive classrooms as regular teaching practices for more engaging and interactive learning experience. Immersive technologies like virtual reality and augmented reality are likely to be essential tools used for improving students' learning outcomes, interest, and proficiency in different subjects. Integrating immersive technologies into teaching content and curricula can further enhance teaching practices as well as learner engagement and performance. These studies suggest further research to better understand the optimal conditions for using immersive technologies in education and to assess the long-term impact on student learning outcomes and academic performance. Since technology integration is indispensable in education, future teaching practices would need to consider factors such as the cost and availability of technology, development of teacher training programs, curriculum alignment, and instructional teaching content development.

V. CONCLUSION

The current study conducted systematic research on the role and relevance of immersive learning on teacher effectiveness. While exploring the relevance of immersive learning on teacher effectiveness and the role of immersive technologies in future teaching practices, it screened and selected 16 articles from IEEE, ERIC, and Google Scholar published during the COVID19 pandemic outbreak (2019-2022) addressing and analyzing immersive technology in teacher education. The selection of these articles was conducted using PRISMA guidelines and the CASP checklist. The findings reported that immersive learning has a positive impact on teacher effectiveness. Over the recent years of technology integration in education, immersive technology has emerged as a

valuable tool for improving teacher education, preparation, and effectiveness. Immersive learning can be instrumental in enhancing the quality of teacher preparation programs and providing professional development opportunities for practicing teachers. Through simulation-based programs, virtual reality-integrated teacher preparation programs, and immersive technology integration in teacher education programs, teachers can improve their teaching practices, self-efficacy beliefs, attitudes towards immersive classrooms, and knowledge, skills, and confidence in managing students' challenging behaviors. However, adequate technical support and training are required to influence teachers' use of immersive technologies and tools in teaching processes. The availability and cost of technology, teacher training, and curriculum alignment remain critical factors to consider when integrating immersive technology in education. Additionally, purpose-designed immersive curricula can enhance student engagement, learning outcomes, and satisfaction. In other words, immersive technology has the potential to transform education by providing more engaging, interactive, and effective learning experiences. Due to the limitations of its use in current education systems, more systematic inquiries are needed for a better understanding of immersive technology integration and implications in teaching and learning processes at different levels and with a wider range of perspectives. Future research should focus more on the long-term impact of immersive learning on teacher effectiveness and teacher education as a whole.

REFERENCES

[1] P.-S. Seow, G. Pan, and G. Koh, "Examining an experiential learning approach to prepare students for the volatile, uncertain, complex and ambiguous (VUCA) work environment," *Int. J. Manage. Educ.*, vol. 17, no. 1, pp. 62–76, Mar. 2019, doi: 10.1016/j.ijme.2018.12.001.

[2] A. Alam and A. Mohanty, "Metaverse and posthuman animated avatars for teaching-learning process: Interperception in virtual universe for educational transformation," in *Proc. Int. Conf. Innov. Intell. Comput. Commun.*, 2022, pp. 47–61, doi: 10.1007/978-3-031-23233-6_4.

[3] Y. Goh, J. Q. Y. Owyong, Y. M. Seetoh, Y. Hu, M. Chng, and Z. Li, "Exploring pedagogies used in undergraduate mental health nursing curriculum: An integrative literature review," *Int. J. Mental Health Nursing*, vol. 30, no. 1, pp. 47–61, Feb. 2021, doi: 10.1111/inm.12816.

[4] E. Jääskä and K. Aaltonen, "Teachers' experiences of using game-based learning methods in project management higher education," *Project Leadership Soc.*, vol. 3, Dec. 2022, Art. no. 100041, doi: 10.1016/j.plas.2022.100041.

[5] D. Howley, "Experiences of teaching and learning in K-12 physical education during COVID-19: An international comparative case study," *Phys. Educ. Sport Pedagogy*, vol. 27, no. 6, pp. 608–625, Nov. 2022, doi: 10.1080/17408989.2021.1922658.

[6] D. Evenhouse, Y. Lee, E. Berger, J. F. Rhoads, and J. DeBoer, "Engineering student experience and self-direction in implementations of blended learning: A cross-institutional analysis," *Int. J. STEM Educ.*, vol. 10, no. 1, p. 19, Mar. 2023, doi: 10.1186/s40594-023-00406-x.

[7] H. Xie, H.-C. Chu, G.-J. Hwang, and C.-C. Wang, "Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of journal publications from 2007 to 2017," *Comput. Educ.*, vol. 140, Oct. 2019, Art. no. 103599, doi: 10.1016/j.compedu.2019.103599.

[8] D. L. Piccolo, S. D. Livers, and S. L. Tipton, "Adapting student teaching during the COVID-19 pandemic: A comparison of perspectives and experiences," *Teacher Educator*, vol. 56, no. 3, pp. 229–249, Jul. 2021, doi: 10.1080/08878730.2021.1925382.

[9] A. Bahari and L. Gholami, "Challenges and affordances of reading and writing development in technology-assisted language learning," *Interact. Learn. Environ.*, vol. 31, no. 10, pp. 7226–7250, Apr. 2022, doi: 10.1080/10494820.2022.2065308.

[10] R. Liu, L. Wang, J. Lei, Q. Wang, and Y. Ren, "Effects of an immersive virtual reality-based classroom on students' learning performance in science lessons," *Brit. J. Educ. Technol.*, vol. 51, no. 6, pp. 2034–2049, Nov. 2020, doi: 10.1111/bjet.13028.

[11] M. Bower, D. DeWitt, and J. W. M. Lai, "Reasons associated with pre-service teachers' intention to use immersive virtual reality in education," *Brit. J. Educ. Technol.*, vol. 51, no. 6, pp. 2215–2233, Nov. 2020, doi: 10.1111/bjet.13009.

[12] A. Kumar, "Gamification in training with next generation AI-virtual reality, animation design and immersive technology," *J. Experim. Theor. Artif. Intell.*, vol. 2022, pp. 1–14, Sep. 2022, doi: 10.1080/0952813x.2022.2125080.

[13] K.-H. Cheng, "Teachers' perceptions of exploiting immersive virtual field trips for learning in primary education," *J. Res. Technol. Educ.*, vol. 54, no. 3, pp. 438–455, May 2022, doi: 10.1080/15391523.2021.1876576.

[14] N. Pellas, A. Dengel, and A. Christopoulos, "A scoping review of immersive virtual reality in STEM education," *IEEE Trans. Learn. Technol.*, vol. 13, no. 4, pp. 748–761, Oct. 2020, doi: 10.1109/TLT.2020.3019405.

[15] A. Christopoulos, S. Mystakidis, N. Pellas, and M.-J. Laakso, "ARLEAN: An augmented reality learning analytics ethical framework," *Computers*, vol. 10, no. 8, p. 92, Jul. 2021, doi: 10.3390/computers10080092.

[16] R. Sarkis-Onofre, F. Catalá-López, E. Aromataris, and C. Lockwood, "How to properly use the PRISMA statement," *Systematic Rev.*, vol. 10, no. 1, p. 117, Dec. 2021, doi: 10.1186/s13643-021-01671-z.

[17] H. A. Long, D. P. French, and J. M. Brooks, "Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis," *Res. Methods Med. Health Sci.*, vol. 1, no. 1, pp. 31–42, Sep. 2020, doi: 10.1177/2632084320947559.

[18] H. Pratama, M. N. A. Azman, G. K. Kassymova, and S. S. Duisenbayeva, "The trend in using online meeting applications for learning during the period of pandemic COVID-19: A literature review," *J. Innov. Educ. Cultural Res.*, vol. 1, no. 2, pp. 58–68, Dec. 2020, doi: 10.46843/jiecr.v1i2.15.

[19] R. Rayuwati, "How educational technology innovates distance learning during pandemic crisis in remote areas in indonesia?" *Int. Res. J. Manage., IT social Sci.*, vol. 7, no. 6, pp. 161–166, Nov. 2020, doi: 10.21744/irjmis.v7n6.1032.

[20] L. Nadolny, A. Valai, N. J. Cherrez, D. Elrick, A. Lovett, and M. Nowatzke, "Examining the characteristics of game-based learning: A content analysis and design framework," *Comput. Educ.*, vol. 156, Oct. 2020, Art. no. 103936, doi: 10.1016/j.compedu.2020.103936.

[21] O. Shatunova, G. Bozhkova, B. Tarman, and E. Shastina, "Transforming the reading preferences of today's youth in the digital age: Intercultural dialog," *J. Ethnic Cultural Stud.*, vol. 8, no. 3, pp. 62–73, May 2021, doi: 10.29333/ejecs/347.

[22] J. Knox, B. Williamson, and S. Bayne, "Machine behaviourism: Future visions of 'learnification' and 'datafication' across humans and digital technologies," *Learn., Media Technol.*, vol. 45, no. 1, pp. 31–45, Jan. 2020, doi: 10.1080/17439884.2019.1623251.

[23] M. J. Page et al., "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," *Int. J. Surg.*, vol. 88, Apr. 2021, Art. no. 105906, doi: 10.1016/j.ijsu.2021.105906.

[24] Y. Shen, Z. Wang, M. Li, J. Yuan, and Y. Gu, "An empirical study of geography learning on students' emotions and motivation in immersive virtual reality," *Frontiers Educ.*, vol. 7, Feb. 2022, Art. no. 831619, doi: 10.3389/feduc.2022.831619.

[25] A. Dengel, J. Buchner, M. Mulders, and J. Pirker, "Beyond the horizon: Integrating immersive learning environments in the everyday classroom," in *Proc. 7th Int. Conf. Immersive Learn. Res. Netw. (iLRN)*, May 2021, pp. 1–5, doi: 10.23919/iLRN52045.2021.9459368.

[26] I. Maheshwari and P. Maheshwari, "Effectiveness of immersive VR in STEM education," in *Proc. 7th Int. Conf. Inf. Technol. Trends (ITT)*, Nov. 2020, pp. 7–12, doi: 10.1109/ITT51279.2020.9320779.

[27] B. Marks and J. Thomas, "Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory," *Educ. Inf. Technol.*, vol. 27, no. 1, pp. 1287–1305, Jan. 2022, doi: 10.1007/s10639-021-10653-6.

[28] C. Chen, "Immersive virtual reality to train preservice teachers in managing students' challenging behaviours: A pilot study," *Brit. J. Educ. Technol.*, vol. 53, no. 4, pp. 998–1024, Jul. 2022, doi: 10.1111/bjet.13181.

[29] I. Stojšić, A. Ivkov-Džigurski, and O. Marič ić, "Virtual reality as a learning tool: How and where to start with immersive teaching," in *Didactics of Smart Pedagogy*. Cham, Switzerland: Springer, 2019, pp. 353–369, doi: 10.1007/978-3-030-01551-0_18.
[30] I. Stojšić, A. Ivkov-Džigurski, and O. Marič ić, "The readiness of geography teachers to use mobile devices in the context of immersive technologies integration into the teaching process," *Geographica Pannonica*, vol. 23, no. 2, pp. 122–134, 2019, doi: 10.5937/gp23-20762.
[31] B. Lane and C. Havens-Hafer, "Teaching the teachers with immersive technology: Preparing the next generation of educators at ithaca college," in *Immersive Education*. Cham, Switzerland: Springer, 2022, pp. 153–170, doi: 10.1007/978-3-031-18138-2_10.
[32] R. M. Hein, C. Wienrich, and M. E. Latoschik, "A systematic review of foreign language learning with immersive technologies (2001–2020)," *AIMS Electron. Electr. Eng.*, vol. 5, no. 2, pp. 117–145, 2021, doi: 10.3934/electreng.2021007.
[33] D. Davis and J. Abbitt, "An investigation of preservice teachers' integration of an immersive virtual reality technology," *Contemp. Issues Technol. Teacher Educ.*, vol. 21, no. 3, pp. 834–858, 2021.
[34] G. Billingsley, S. Smith, S. Smith, and J. Meritt, "A systematic literature review of using immersive virtual reality technology in teacher education," *J. Interact. Learn. Res.*, vol. 30, no. 1, pp. 65–90, 2019.
[35] G. Gómez-García, F.-J. Hinojo-Lucena, S. Alonso-García, and J.-M. Romero-Rodríguez, "Mobile learning in pre-service teacher education: Perceived usefulness of AR technology in primary education," *Educ. Sci.*, vol. 11, no. 6, p. 275, Jun. 2021, doi: 10.3390/educsci11060275.
[36] K. D. Hager, "Integrating technology to improve teacher preparation," *College Teaching*, vol. 68, no. 2, pp. 71–78, Apr. 2020, doi: 10.1080/87567555.2020.1723475.
[37] O. Heaysman and B. Kramarski, "Supporting teachers' SRL beliefs and practices with immersive learning environments: Evidence from a unique simulations-based program," in *Proc. 7th Int. Conf. Immersive Learn. Res. Netw. (iLRN)*, May 2021, pp. 1–5, doi: 10.23919/iLRN52045.2021.9459418.

DIPIMA BURAGOHAIN (Senior Member, IEEE) received the Ph.D. degree in linguistics from Jawaharlal Nehru University, India. She is currently with the School of Foreign Languages, Guangdong University of Petrochemical Technology, Maoming, China. She has more than 15 years of experience in teaching, research, and the corporate industry. She has published 31 papers in high-impact and international journals, conference proceedings, and book chapters, and 19 books of academic and creative references. Her research interests include digital and immersive learning, metaverse, educational technologies, ESL/EFL studies, documentation of endangered and lesser-known languages, and multidisciplinary research.

CHAOQUN DENG is currently an Associate Professor with the School of Foreign Languages, Guangdong University of Petrochemical Technology, Maoming, China. She has 17 years of teaching experience. Her research interests include teacher assessment literacy, e-learning, and English teaching.

ABHISHEK SHARMA (Senior Member, IEEE) received the B.E. degree from the Sant Longowal Institute of Engineering and Technology and the M.Tech. degree from Punjab Technical University. He is currently pursuing the Ph.D. degree with the Faculty of Engineering and Technology, Guru Nanak Dev University, Amritsar. He has ten years of experience in teaching. His research interests include free space optics, radio over free space optics, spatial division multiplexing, metaverse, and E-learning.

SUSHANK CHAUDHARY (Senior Member, IEEE) received the Ph.D. degree from Universiti Utara Malaysia, Malaysia. From 2018 to 2020, he was with Fujian Institute of Research on the Structure and Matter, Chinese Academy of Sciences, as a Postdoctoral Researcher. He is currently with the School of Computers, Guangdong University of Petrochemical Technology, Maoming, China. He has published more than 85 research articles in SCI, Scopus international journals, and international conferences. His main research interests include free space optics, photonic radar, and immersive technologies for teaching, metaverse, and digital twin. In 2019, he was awarded an Elite Talent Award from Jinjiang Government, China. He has delivered keynote speeches at the Technology Transfer Summit, Jinan, China, and the IEEE International Conference on Signal Processing and Integrated Networks, SPIN 2020, Noida, India.