

REVIEW ARTICLE

The contributions of using immersive environments for a competence-based teaching in basic education: An integrative review

Maryana Schenfelder Schneider*, Camila Maldonado Huanca

Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, São Paulo 01000-000, Brazil. E-mail: maryschenfelder@usp.com.br

ABSTRACT

The adoption of the Common National Curricular Base and the New High School Law necessitates a cultural shift in basic education, with a focus on skill and competency development. Considering this, the purpose of this study was to research in the literature the contributions of immersive environments as an educational tool for competency-based teaching. Articles from the CAPES database and the key journals dealing with information technology in education in Brazil were collected using an integrated literature review. The articles examined provided several techniques for leveraging immersive settings in teaching, such as “virtual worlds”. It was discovered that innovative proposals have the potential to develop competencies and skills.

Keywords: BNCC; basic education; CAPES articles; skills; abilities

1. Introduction

The demand for innovative practices in the classroom is constant. Therefore, changes in culture within the school are necessary to keep up with the challenges of contemporaneity, seeking to meet the social demands and the young people who are in school today. The so-called digital natives, which Prensky^[1] defines as those who were born and raised with digital technologies present in their lives, are today’s students. So, the use of technologies applied to education brings contributions to the teaching and

learning process. According to Tori, studies show us relevant advances in working with information technologies in the educational context and their contributions to the teaching and learning processes that provide students with a meaningful experience^[2].

To meet this generation of students who are in school, the federal government has been launching, in recent years, a series of actions that seek to adapt the school to different realities. With the implementation of the Base Nacional Comum Curricula (BNCC) and the New High School Law No. 13.415/2017, an education guided by competencies

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is now guiding the teaching practices of basic education teachers across the country.

Both mentioned documents deal with educational standards, which should be implemented in the coming years. Thus, education professionals need to adapt their practices taking into account the full development of students in all areas: affective, professional, cognitive, and personal, in order to build a fairer, more democratic, and inclusive society^[3].

The BNCC presents the following concept of competence in education:

“[...] Competence is defined as the mobilization of knowledge (concepts and procedures), skills (practical, cognitive and socioemotional), attitudes and values to solve complex demands of everyday life, the full exercise of citizenship and the world of work”^[3].

Zabala and Arnau, in their book *How to Learn and Teach Competencies*, define competence and point out that:

“Competence in the context of school education should identify what any person needs to respond to the problems

to which he or she will be exposed throughout life. Therefore, competence will consist of effective intervention in the different areas of life through actions in which attitudinal, procedural and conceptual components are mobilized at the same time and in an interrelated manner”.

According to Zabala and Arnau and the BNCC, competence-based education involves the integration of a set of skills and abilities that mobilize different components in an interrelated manner to meet learning objectives. In view of this, its relevance to the comprehensive training of students can be seen, especially in the period of basic education.

The BNCC defines that the curricula of schools and education systems, in addition to ensuring students the development of basic skills that are defined in this document, also need to certify to students, the development of ten general competencies, which unify, at the pedagogical level, the rights to learning and development^[3]. The 10 generic competencies defined by the BNCC are shown in **Figure 1**.

General Competences of the New BNCC



Figure 1. BNCC general competencies.

Once again, these generic competencies are interrelated and unfolded in the didactic and pedagogical approach proposed for the three stages of basic education (kindergarten, elementary and secondary education), articulating the construction of knowledge, the formation of attitudes and values, and the development of skills, thus meeting the Law of Directives and Bases (LDB)^[3].

Immersive technologies are increasingly gaining space in the educational context, as they allow greater customization of learning, providing a more authentic experience to students, allowing them to experience different real world situations. Virtual reality, augmented reality, and virtual worlds are beginning to bring new experiences of immersive learning, of viewing materials, of interacting with stories, characters, and the environment.

2. Objectives

In view of this reality and with the hypothesis

that digital technologies can contribute to a more meaningful learning, the work, whose results are reported in this article, aimed to research in the literature how immersive environments can contribute, as an educational tool, to the teaching of competencies and skills in basic education; the contributions of the use of immersive technologies for a competence-based teaching in basic education; and the impacts on learning with the use of immersive environments in competence-based teaching.

3. Methodology

As a way to understand the object of study proposed in the research presented here, an integrative literature review was developed for the synthesis of knowledge^[4].

The articles studied were extracted from the CAPES database, but, due to the few results found, a manual search was conducted in the main journals

related to the area of informatics in education in Brazil: Renote, Brazilian Journal of Informatics in Education (RBIE), informatics in education-theory and practice and annals of the Brazilian Symposium on Informatics in Education (BSIE). The following keywords were used to search the articles: immersive environments, competencies, skills, competencies and abilities, virtual reality, augmented reality, virtual world, BNCC, New High School Law.

A total of 484 articles were found with some of the keywords mentioned. The words: BNCC and New High School Law did not return any results. After applying the inclusion and exclusion criteria (**Table 1**), 12 articles remained, which were analyzed, verifying that the studies met the objectives cited in this integrative literature review, according to the flowchart (**Figure 2**).

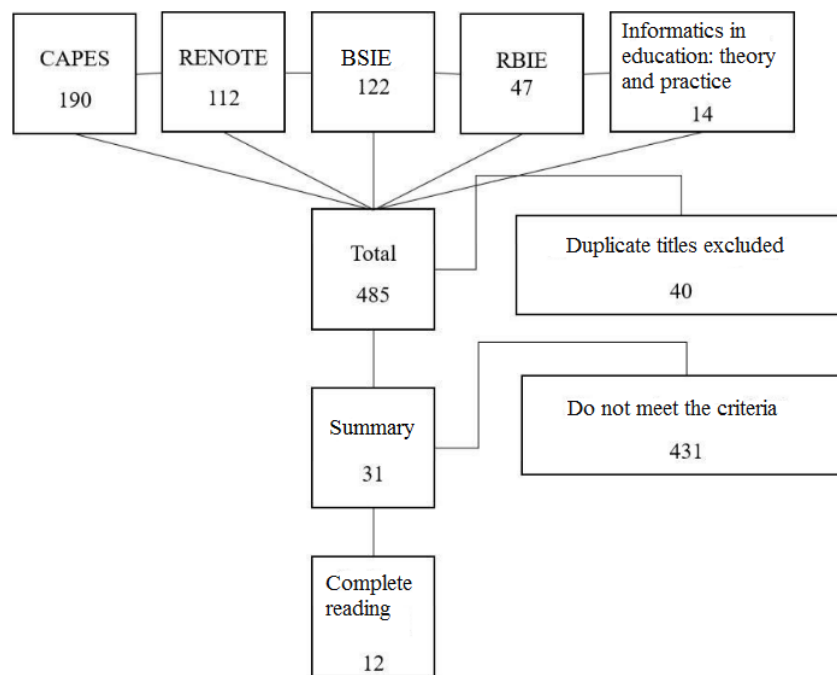


Figure 2. Flowchart of the process of the articles included in this review.

Table 1. Inclusion and exclusion criteria of the included articles

Inclusion criteria	Exclusion criteria
Published in the period 2000 to 2020	Duplicate articles
Use immersive technology	Articles that show no evidence of competence-based teaching
Potential for competence-based teaching	International experiences
Used in elementary education	Articles that were not available in full

4. Results

To better extract information from the selected articles, an instrument was built with the following criteria, article name, keywords, year, journal, database, country, audience, technology, objective,

methodology, and results. Through this instrument, it was possible to collect the relevant data from each article studied and, with this data, to clearly construct a critical analysis that was later used to build this integrative review.

Table 2 presents an overview, highlighting the most important points of the data collected by means

of the instrument cited in the articles selected for this study.

Table 2. Overview of the selected articles

Topic	Reference	Goal
AR in mathematics teaching.	[10]	Expand the discussion of the use of “mobile” in the classroom.
Virtual world applied to education.	[7]	Revive students’ interest in learning concepts using <i>OpenSim</i> .
Learning through digital games.	[11]	Reflect on the production of digital games that enable active student participation in educational, social, and cultural contexts.
Considerations for designing educational applications.	[17]	Rescue information from educational software to virtual worlds.
VR for cooperative learning.	[12]	Enable the use of VR, to support collaborative learning.
Project-based learning using virtual worlds	[13]	Collaboratively develop knowledge.
AR in mathematics teaching	[14]	Use location-based games to rescue students’ interest in different concepts.
Virtual worlds in physics teaching	[8]	Investigate the applicability. Simulation resources pedagogical of physical phenomena in virtual worlds.
Study of ICT’S developed for teaching skills and abilities	[19]	Investigate scientific papers that address the production of digital technologies to mediate the development of skills and abilities.
AR in science education	[4]	Investigate whether the application using AR contributes to the teaching and learning process.
Virtual world and the contributions to the teaching and learning process.	[18]	Present the contributions of immersive environments to learning.
VR in teaching geography	[21]	Analyze the possibilities of using VR technology for teaching geography.

5. Discussions

The objectives directed all the reading of the selected articles, which was carefully carried out in order to highlight the points that present the contributions of using immersive environments in competence-based teaching in basic education.

Thus, the selected articles are classified into two categories: theoretical and educational tool.

The selected articles, particularly those classified as educational tools, bring relevant data that contribute, in some way, to achieve the research objectives. However, it is important to emphasize that no national results were found that use immersive tools focused on competence-based teaching in basic education. In the studies found and analyzed, the use of active methodologies that seek the development of different competencies stands out, but is addressed in a superficial way. Even with

the use of immersive technologies that are extremely innovative, much of what is developed sustains the fragmented thinking in the teaching model based on the learning of disciplinary knowledge, organized around conventional subjects that have little focus on the student’s protagonism and end up repeating teaching and learning models based on memorization and the transmission of content.

Freire’s work *Pedagogy of the Oppressed*^[5], denounces this teaching methodology, calling it banking education:

“[...] education becomes an act of depositing, in which the students are the depositaries and the educator is the depositor. Instead of communicating, the educator communicates and makes deposits that the students, mere incidents, patiently receive, memorize, and repeat. This is the banking conception of

education, in which the only room for action offered to the students is to receive the deposits, keep and archive them^[5].

Pereira and Peruzza point out that virtual reality goes beyond just a form of learning, it should also be thought of to reach areas where traditional methods are no longer enough.

Among the alternatives provided by Information and Communication Technologies (ICT) are virtual worlds, which are online environments generated by computers where people can interact, as a form of leisure or even work in a way analogous to the real world^[6].

Virtual worlds also enable a high level of user immersion, since they are developed in a three-dimensional environment. Virtual worlds, also known as Metaverse, which is a virtual reality application that promotes experiences very close to reality and makes it possible to simulate real situations in students' daily lives, considering the different realities in which young people are inserted. The most popular virtual environments are *Second Life* and *OpenSim*, which allow the connection of multiple users and interaction among them through avatars. What is most striking about these environments is that users can create their own objects and program their behavior, and interact with them as well as with other avatars. Everything in this environment was created by its users and it is possible to create a school, develop activities, interact with colleagues, evaluate students all within the virtual worlds^[2].

Educational institutions have been investing in immersive environments, such as *Second Life* and *OpenSim* to develop classes, disseminate productions and also analyze the behavior/reciprocity of an artifact in the virtual world to obtain answers for the real world^[7]. In this study, Elia and Azevedo present a work proposal with high school students from a public school in Rio de Janeiro, using immersive environments. With the

virtual worlds the students were able to develop skills and abilities as well as contents related to the Portuguese language. In the work, the students were invited to create their avatars using *OpenSim*, building in the virtual environment what they consider an "Ideal School".

In these activities, the results and the reports presented showed great potential for competence-based teaching. By creating the "Ideal School", a series of knowledge, procedures and attitudes were put into practice by the students to create, in this virtual environment, the desired physical space. The involvement among students, sharing and cooperation were evidenced in the research showing potential for the development of competencies such as: argumentation, empathy and cooperation, self-knowledge, digital culture, knowledge, work and life project, responsibility and citizenship^[7].

The article by Marques, Greis and Reategui presents the use of a virtual world as an educational tool to develop, in elementary school students, concepts related to the Physics curricular component. The researchers aimed to verify if the level of immersion and interactivity of 3D virtual environments are relevant factors for a greater engagement and learning by the students. To this end, a simulator was created in the 3D environment *Second Life* for the development of concepts related to physical phenomena (physical concepts of mass and velocity in the collision of two bodies). According to researchers, it is common to approach physics concepts without conducting practical experiments or proposing concrete problem situations to be solved^[8]. That is why it is important to seek strategies and teaching resources that bring a significant learning experience, in order to facilitate and qualify the teaching and learning process, fostering the development of comprehensive education, based on the development of competencies and skills.

According to Zaballa and Arnau^[9]:

“Simulation consists of placing students in front of a condition or context that mimics relevant aspects of reality and developing, in that environment, problem situations or demands proper to the discipline and that require the student to develop the competence that is being the subject of development and assessment.”

The research did not focus on teaching by competencies, but rather sought a model for applying an immersive didactic tool, in this case *Second Life* as a simulator. To develop the students' learning, their prior knowledge was considered as the necessary knowledge was introduced. In this way, the students acquired the necessary concepts so that they could apply and interact with the proposed problem situation and, with the help of the simulator, find a solution, being able to verify and test their hypotheses as many times as necessary. In the qualitative approach, the researchers verified the students' engagement and learning. By proposing to build this simulator in the 3D virtual environment, the researchers sought to provide more complex levels of interactivity, new ways to discuss classroom content as well as new forms of communication. Situations involving pedagogical components, gaming and simulation elements were also constructed, which together formed an educational experience with the potential to provide students with higher levels of engagement and advances in learning processes^[8].

The researchers found the expected results in relation to engagement, since technology by itself provides the student's interest in developing the activities. In relation to learning, they verified that the students met the proposed objectives and that the “engagement” factor contributed to the achievement of the objectives. The articles in the educational tool category pointed out that in recent years research has expanded that aims to foster collaborative and cooperative learning in computer-supported

environments, as well as the development of cognitive skills, such as problem solving^[7,8,10-14].

The teaching methodology based on problem solving is characterized as a way of educating based on the perspective that the construction of knowledge is favored by actions that enable the articulation of different areas of knowledge and culture, besides allowing to relate the concepts learned with current issues of everyday life; encourages interpersonal relationships, socialization, teamwork and the ability to cooperate, research and communicate^[15]. Thus, new teaching proposals that provide different forms of learning that stimulate the development of intellectual autonomy through learning situations that promote reasoning and collective problem solving, such as electronic games, AR and VR applications, and virtual worlds, are necessary.

The study proposed by Franco, Lopes, Ferreira and Stori^[13] shows a collaborative and interdisciplinary experience which uses the computer as a support, whose implementation contributed to expand the technical, intellectual and pedagogical knowledge of the students^[13]. The 3D interactive environments were used to solve a problem related to the cultural historical heritage of the village of Carapicuíba, applying the problem-based methodology and relating knowledge from different areas: arts, education, culture and technology.

When addressing a cultural historical heritage in the research, skills such as knowledge and cultural repertoire were involved^[3].

The digital culture was present throughout the process, because through the 3D interactive environment it was possible to understand, use and create in a critical, reflective and meaningful way within the environment. Communication was also present when using different languages, verbal and non-verbal to express and share information, experiences, ideas, and feelings^[3].

Although the study did not focus on

competence-based teaching, the collaborative construction of interactive 3D environments and their potential for interdisciplinary work contributed to competence-based teaching. As a result, applications in 3D virtual environments, such as virtual worlds, showed potential for competence-based teaching, since they enable the construction of proposals using methodologies suitable for different realities.

This approach to transdisciplinary work, proposed by the main guiding documents for Brazilian basic education^[3] favors competence-based teaching since, from this perspective, these competencies are worked on through integrative projects on contemporary issues that affect human life, and to solve these problems it is necessary to put into practice procedural, conceptual, and attitudinal components.

According to Zaballa and Arnau^[16], the didactic sequences are built considering the development of competences, such as argumentation. In this article, by Souza and Abreu, a didactic sequence with AR was used to develop Physics concepts related to the Solar System, besides the proposal of a debate. Although the article does not focus on teaching by competencies, the didactic sequence proved to have potential for the development of competencies using Augmented Reality (AR) technology. Regarding the knowledge acquired by students, the researchers found that there was a greater learning of the content worked using the AR technology.

According to Tori:

“AR opens numerous application possibilities, such as games that unite the flexibility provided by the computer with the freedom of movement of real spaces, or like educational tools that project images onto objects or the human body itself simulating a virtual X-ray”^[2].

The study by Macedo and Goes^[10] presents an AR application created to support the teacher’s work

related to the development of general and specific skills in the area of mathematics. The article presents the Polyedra App, an AR application for working with spatial geometry in high school. The use of smartphones was essential, since students use their own devices to develop the proposed activities that resulted in learning, cooperation, trust, autonomy and interactions among students and with the teacher^[10].

From the point of view of the classroom environment, the research showed that AR favored the exchanges between students-teacher-content, maintaining a motivational effect that enhanced collaborative work and maintained a learning climate. The researchers also found that the activities with AR as a support for the teacher’s work in the classroom, favored the dialogue and interactivity between teacher and students contributing to a more meaningful learning, favoring the inclusion of media, the observation of geometric objects and reflections on them, not failing to highlight the playful aspect involved^[10].

The selected theoretical articles point to an urgency of the appropriation of teachers in the use of ICT for educational purposes to develop a more meaningful learning^[17-19]. For Kozma^[20], learning is seen as an active and constructive process where the learner is at the center of the learning process and conducts the cognitive resources available in a strategic way to create new knowledge, new learning, extracting information from the environment and integrating it with information already stored in memory. All these reasons point to the importance of better educational practices that meet the new demands of a knowledge society.

According to Giraffa^[17]:

“The generation of students that are currently in school, the so-called digital natives, are being taught and tutored by digital immigrants, the teachers were not born immersed in a context of massive

use of technologies - they had to develop competencies and skills to be able to adapt to this new context”.

In fact, even with the evolution of technology and the renewals of curricula and public policies carried out over the years, we see few transformative changes in Brazilian schools regarding the use of technology applied to education, as well as in the use of immersive technologies within this context. Oliveira and Hildebrand^[11] ratify the idea that technologies will make a difference in the teaching and learning process if significant changes can be made in the behavior of teachers and students.

ICT's have brought much more than a technological revolution, but also a behavioral revolution that facilitates the forms of communication between people, creating a new perspective related to knowledge, skills and abilities^[17]. This perspective relies on a more active participation of the student, putting him/her at the center of the learning process that should be based on the integral formation of the student.

However, it is important to be cautious in the use of technologies in educational contexts^[2] as well as in the use of immersive technologies so that the same classroom practices of a fragmented teaching model are not reproduced by curricular subjects based on the transmission of content and memorization, which bear no relation to the student's reality.

The study by Santos and Bulamarqui^[19] verified, through a systematic literature review, the articles that addressed the production of digital technologies (except immersive technologies) to mediate the development of skills and abilities of elementary school students after the BNCC. Then, the digital technologies adopted, the curriculum components, and the contribution of digital technologies to the acquisition of skills and abilities were identified.

Few articles have addressed the development of competencies and skills, some technologies

produced have ensured the success in teaching by competencies and few research results address the potential of digital technologies for a teaching by competencies. However, it is believed that, with the approval of the BNCC, studies may develop and contribute even more to the work of teachers in the development of students in basic education.

In this integrative review, the articles selected and classified as theoretical, mostly concluded that ICT's and immersive environments applied to education have great potential as an educational tool to support the teacher's work^[17-19].

In addition to simulating real circumstances, students can experience and experiment with various learning situations, which often cannot be possible in school because they are expensive or difficult to access. It is believed that, with the approval of the BNCC, the studies can develop and contribute even more to the work of the teacher in the development of students in basic education.

Although the selected articles did not have as a research objective the contributions of the use of immersive technologies for competence-based education, it was possible to identify through the results presented some contributions that immersive technologies can bring to competence-based education.

It is important to point out that the methodology used with the support of these tools can make a difference in the students' learning, causing positive impacts on the acquisition of knowledge and generating significant learning through immersion.

Immersive digital technologies such as virtual worlds, virtual reality, and augmented reality are tools that show great potential, especially when applied to education.

“[...] Integrating virtual and real information in the same environment is a very efficient way to put students in front of distant or inaccessible content or people, without removing their

perceptions regarding the real environment that surrounds them”^[2].

These technologies allow students to experience simulations and create different situations to build meaningful learning with experiences very close to reality, corroborating with Mattar^[21], who highlights the potential of simulations and roleplaying in 3D virtual environments for education. Such environments allow students to assume various roles, experience and explore life skills in different situations in virtual space, situations that often cannot be experienced safely and easily in the real world.

Simulation-based teaching strategies can be considered a technique or an activity that can be used at a given time to deepen or understand a specific situation or practice a procedure or set of procedures. Thus, through intentional activities, where students are placed in situations of experimentation, it is possible to build didactic situations that address all phases of teaching for the development of life skills^[9].

The BNCC presents as one of the 10 general competencies: Digital culture established for:

“Understand, use, and create digital information and communication technologies in a critical, meaningful, reflective, and ethical way in various social practices (including school practices) to communicate, access and disseminate information, produce knowledge, solve problems, and exercise protagonism and authorship in personal and collective life”^[3].

This competence described in the BNCC realizes the important role that technology plays in life in society and determines that students need to master this digital world, becoming able to use such technology effectively and ethically, understanding computational thinking and the effects that

technology has on people’s lives and society. In view of this, the results, although not primarily focused on competence-based teaching, presented practices with the potential to contribute to the teaching of this competence.

The results of the articles studied, in order to find the collaborations of the use of immersive technologies for competence-based teaching, showed that immersive digital technologies such as virtual worlds, virtual reality and augmented reality favor the use of differentiated methodologies centered on the student based on challenges, problem situations and games, where it is possible that each student can learn at his own pace according to his needs by learning with others in groups and also in projects^[22].

It is urgent that teachers incorporate into their practices differentiated methodologies to better serve the young students who are in school. The use of immersive technologies can help the teacher to develop better practices in the classroom. However, it should be noted that even with immersive technologies, augmented and virtual reality, and 3D virtual environment, after the novelty period has passed, there is the possibility of continuing to perpetuate a traditional model of teaching based on memorization and transmission of content may have the opposite results and the proposed learning objectives may not be achieved.

Another collaboration that the articles brought was in relation to the concept of Zone of Proximal Development developed by Vygotsky, the concept of Zone of Proximal Development (ZPD) happens when the learner has not yet consolidated a knowledge completely. The distance between the actual development level and the potential development level characterizes the “Zone of Proximal Development”. These are those functions that have not yet matured, but are in the process of maturation; functions that will mature, but are present in an embryonic state^[23].

Working in pairs favors the ZPD, the articles

studied presented collaboration in this sense, through the results, the shared dialogues, and the learning reported^[7,10,13].

In the selected articles, none of them presented competence-based teaching as a research focus. However, students were found to have increased motivation, engagement, collaboration and cooperation.

6. Conclusions

The approval of the BNCC brought to teachers of basic education, a challenge in relation to the teaching processes in which a model focused on the development of skills and abilities becomes the guideline for the construction of the curricula of the entire Brazilian education network. In view of this, a change in education is urgent. It is necessary to adopt new methodologies that promote the participation of students in an active way, with meaningful learning that fulfills its role in the human formation of the student, the protagonist of his history. It is necessary to imagine a new learning environment, with information in the palm of their hands, where students are challenged and motivated to give their opinions, participate in process improvements, and contribute to a collective construction of knowledge.

Taking into account the social demands and the young digital native, it is more than necessary that teachers adopt practices that support their work and contribute to develop meaningful learning in the classroom. Digital technologies can be resources that contribute to these practices since they provide greater motivation and engagement to the students as shown in the articles studied in this integrative review. Even with the choice of a digital technology applied to education, it is necessary to think of methodologies that favor the work with students and that take into account the normative documents that guide the Brazilian basic education, such as the BNCC, which present a teaching model based on the development of competencies and skills. Although

significant results have been found in the development of concepts in the areas of physics, mathematics, geography, Portuguese language, history and arts using immersive digital technologies, these researches have not focused on the development of competencies and skills, because much of what is developed still reproduces models based on content transmission and memorization.

In the results, we also noted the great potential of virtual worlds as immersive technologies for competence-based teaching. The experience of living in a virtual world allows students to simulate and experience real-life situations, being able to put into practice different conceptual, procedural and attitudinal components to solve the problem situations proposed in these environments, which are very close to reality and provide strong motivation in students.

It is necessary that these competencies and abilities foreseen in the normative documents are considered in the planning and authoring of activities in all contexts, including when digital technologies are used, so that the same teaching model is not reproduced where the student does little. When thinking about developing a work with immersive technologies with virtual worlds, VR and AR, it is necessary to have pedagogical intentionality with clear objectives of where one wants to go with the use of these technologies.

Therefore, there is great potential for future studies regarding the development of research that uses immersive technologies as an educational tool focused on competence-based teaching.

Conflict of interest

The authors declare no conflict of interest.

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