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Article

Exploring the impact of the metaverse on English language teaching: Perspectives of students from the University of Boyacá

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Abstract: This study investigates the impact of the metaverse on English language teaching, focusing on the perspectives of students from the University of Boyacá. The use of the metaverse was compared with the Moodle platform in a virtual educational environment. A mixed-method approach combining quantitative and qualitative methods was employed. The sample consisted of 30 university students enrolled in English courses, randomly assigned to two groups: one using the metaverse and the other using Moodle. Students' grades on different activities and assessments throughout the course were collected, and semi-structured interviews were conducted to explore students' perceptions of the educational platforms. Results revealed that while students recognize the potential of the metaverse to enhance interactivity and learning experience, they also identified technical and accessibility challenges. Although no significant differences in grades were found between the groups, less variability in grades was observed in the metaverse group. The mixed design allowed for a more comprehensive understanding of the impact of the metaverse on English language teaching, while providing a variety of student perspectives on their experience with educational technology. This research contributes to understanding the role of the metaverse in English language teaching and highlights key areas for future research and developments in the field of virtual education.

Keywords: metaverse; educational platforms; learning experience; educational technology; digital learning environment

1. Introduction

The metaverse is an immersive virtual environment that allows users to interact through three-dimensional avatars (Lee, 2022). According to a recent report, the global metaverse market was expected to grow from $61.8 billion in 2022 to $426.9 billion by 2027, at a compound annual growth rate of 47.2% (Markets and Markets, 2022). In the education sector, it was estimated that 23% of higher education institutions would have adopted the metaverse in some capacity by 2025 (Gartner, 2022). While the concept of the metaverse is not new, it has gained prominence in recent years due to advances in immersive technologies and the increase in remote work during the COVID-19 pandemic (Ramos-Soler et al., 2023). In the educational context, the metaverse offers opportunities to enhance learning and collaboration, although it also poses ethical and pedagogical challenges (Southgate et al., 2023).

According to Hamari et al. (2022), immersive technologies such as virtual and augmented reality are key to enabling the sense of presence and agency in the metaverse. 3D virtual worlds offer persistent social spaces where users can interact and communicate synchronously through their avatars (Lee, 2022). The high degree of social presence in these environments promotes collaboration, engagement, and a

sense of community, according to Southgate et al. (2023).

Recent research explored the extension of the Technology Acceptance Model (TAM) to predict university students' intentions to use metaverse-based learning platforms (Park and Kim, 2022). These studies highlighted the importance of factors such as perceived usefulness, ease of use, and social influence in the adoption of the metaverse in higher education.

However, research on the educational use of the metaverse is still in its infancy (Ramos-Soler et al., 2023). More empirical studies are needed to determine its effectiveness for different types of learning and populations (Southgate et al., 2023). Additionally, it is necessary to address access barriers such as the cost of virtual reality devices and potential digital divides (Lee, 2022). From a pedagogical standpoint, the metaverse enables experimental learning, gamification, simulations, and situated application of knowledge (Hamari et al., 2022). Virtual worlds facilitate 3D visualization and kinesthetic learning, benefiting students with different learning styles (Ramos-Soler et al., 2023). However, teacher training is required to design meaningful activities leveraging the technical possibilities (Southgate et al., 2023).

Another advantage is the ability to remotely connect students and guests from different parts of the world (Ramos-Soler et al., 2023). Metaverses provide greater flexibility than video conferencing, allowing interaction and joint immersion in virtual spaces. This expands the possibilities of collaborative learning and exposure to diverse cultures and perspectives (Southgate et al., 2023).

However, for these pedagogical possibilities to materialize, it is crucial to adequately train teachers in the use of metaverses (Lee, 2022). Technical training on platforms and devices, as well as appropriate active methodologies for 3D and immersive environments, are required. Teachers must also develop skills to manage groups and prevent conflicts in these digital social spaces (Hamari et al., 2022).

Furthermore, it is important to involve students in the design of these virtual spaces to ensure meaningful experiences tailored to their needs and interests (Ramos-Soler et al., 2023). Giving voice to young people can bring fresh and innovative ideas about ways to learn in new digital environments (Southgate et al., 2023).

At the institutional level, universities must make the necessary investments in equipment and bandwidth to reduce access gaps to metaverses (Lee, 2022). It is also crucial to develop conduct protocols and moderation systems to prevent and address potential ethical issues in these spaces (Ramos-Soler et al., 2023).

The metaverse offers promising opportunities for education, but requires further empirical research and ethical debate to ensure positive and responsible learning experiences. It is crucial to consider not only the technical potential of these emerging technologies but also their pedagogical, social, and psychological implications. A reflective and student- and teacher-centered implementation will be key to ethically and productively harnessing the educational possibilities of the metaverse.

Despite the growing interest in the metaverse in education, there was a scarcity of empirical studies comparing its effectiveness with traditional platforms like Moodle. Our study addressed this gap by conducting a direct comparison in the context of English language teaching, providing evidence on students' perceptions and performance in both environments. This contributed to a more nuanced understanding of the potential and challenges of the metaverse in higher education. The metaverse

represents new possibilities for education, but also brings challenges that need to be addressed. A key challenge is the reduced interaction among students compared to the traditional classroom, which can affect the development of social skills (Park and Kim, 2022). While virtual platforms enable virtual communication, the lack of face-to-face contact hinders the fluidity of interactions. Therefore, it is essential to complement the metaverse with in-person instances for socio-emotional learning.

Another challenge is the sustained attention required for immersion in virtual environments. Students must regulate their distractions and maintain focus without the close supervision of the teacher (Martín et al., 2022). This demands self-management and self-regulation skills that need to be progressively developed. Institutions can design short activities and intersperse breaks to assist students in this process.

Additionally, training in the use of technologies is required for both teachers and students (Diez, 2023). The digital divide may exclude those without access or skills to participate in metaverses. It is crucial to democratize the learning of digital competencies and have permanent technical support. Choosing user-friendly platforms and intuitive interfaces suitable for users' levels is also necessary.

On the other hand, the metaverse opens up vast possibilities for educational innovation and creativity. Game environments and immersive simulations promote creative thinking and motivation among students (Park and Kim, 2022). Collaborative construction of virtual worlds also stimulates imagination and problem-solving.

From the teaching role, creativity is required to adapt disciplinary content and design meaningful activities in 3D environments (Chavarría and Atúncar, 2023). The metaverse drives the search for new pedagogical strategies focused on active learning and students' interests. For example, scientific experiments can be recreated or immersive trips to different historical periods can be undertaken.

Some innovative examples are metaverses for language teaching, connecting students with native speakers (Anacona Ortiz et al., 2019). There are also hyper-realistic medical simulators for students to practice complex surgical procedures before attending real patients.

Furthermore, Ruiz Campo et al. (2023) implemented teacher training in metaverses, observing greater ease among "digital native" teachers. Although adoption requires a process, the potential to expand distance teaching modalities is positively valued.

Our study was grounded in experiential learning theory (Kolb, 1984) and social presence theory (Short et al., 1976). Experiential learning theory suggested that students learn best through immersive and authentic experiences, such as those the metaverse can provide. On the other hand, social presence theory highlighted the importance of perceived connection and co-presence in virtual environments to facilitate interaction and learning.

Based on these theories, we proposed a conceptual model that explored the relationships between metaverse use, students' perceptions (social presence, user experience), and academic performance. This model suggested that the immersive features of the metaverse can influence students' perceptions, which in turn may affect their performance compared to traditional platforms. Additionally, we considered moderating factors such as digital competence and motivation, which may influence these relationships. This conceptual model provided a framework for exploring the

underlying mechanisms of the metaverse's effectiveness in education. In summary, responsibly leveraging the opportunities of the metaverse in education involves: 1) Integrating it as a complement to in-person learning for comprehensive skill development. 2) Implementing gradually, with ongoing training and technical support. 3) Designing short activities interspersed with breaks to facilitate sustained attention. 4) Promoting creativity and motivation through playful and immersive simulations. 5) Training teachers in innovative pedagogical strategies for 3D environments. 6) Encouraging student participation in the design of virtual spaces for meaningful experiences.

The implementation of metaverses in education is an emerging trend that generates diverse opinions among students and teachers. According to a study conducted by Reyes (2020), high school students who used augmented reality in metaverses to learn mathematics expressed a positive appreciation of this technology. The students highlighted the ease of use, interactivity with 3D objects, and the increased engagement generated by this type of immersive learning.

Similarly, a systematic review by Temoche Villareyes (2023) revealed that research on metaverses in higher education experienced exponential growth following the COVID-19 pandemic. The analysis of publications indicates that the metaverse is perceived by students and teachers as a useful and innovative tool to enhance motivation and achieve meaningful learning.

However, authors like Ruiz-Palmero et al. (2022) caution that the implementation of the metaverse in classrooms should be gradual, starting from the real interests and needs of students. It is important not to fall into technological determinism or adopt these technologies solely because of their novelty. Metaverses are a complementary tool that must be integrated thoughtfully into educational strategies.

From the teacher's perspective, Southgate et al. (2023) point out the need for training to design effective learning experiences in 3D environments. While many teachers value the potential of virtual worlds, lack of digital skills creates insecurity. Creating content and managing groups in metaverses requires constant updating of technical and pedagogical skills.

At the institutional level, Abdullah and Ward (2022) recommend conducting pilot tests before adopting the metaverse on a large scale. This allows for the detection of technical issues, gathering feedback from users, and adjusting instructional designs. It is also crucial to develop ethical guidelines on privacy, content moderation, and prevention of harassment in these environments.

In conclusion, research shows an enthusiastic but cautious view of the application of metaverses in education. Studies highlight their potential to promote motivation and active learning, but emphasize that implementation should be progressive, incorporating teacher training, specialized instructional design, and ethical considerations. More than a passing trend, the metaverse is an innovation that can add value if integrated thoughtfully into educational practices. Further research is needed to continue exploring its possibilities and challenges in various educational contexts.

2. Materials and methods

The present research aimed to compare the effectiveness of immersive learning

in metaverses with traditional online education in Moodle. A quasi-experimental design with random assignment to two groups was used, suitable for contrasting different conditions or treatments (Leavy, 2017).

The objective of this study was to compare the effectiveness of immersive learning in the metaverse with traditional online education in Moodle for English language teaching at the University of Boyacá. Specifically, we aimed to examine students' perceptions and academic performance in both environments.

This study was significant as it provided empirical evidence on the potential of the metaverse in higher education, particularly in the context of language teaching. The findings could inform educators and administrators in decision-making regarding the adoption and implementation of immersive technologies in the classroom. Furthermore, this study contributed to the growing area of research on the metaverse in education, addressing the scarcity of comparative studies with traditional platforms. Participants were 30 students from the University of Boyacá, aged between 18 and 20 years old, selected through stratified random sampling from the first-year student population. Inclusion criteria were being enrolled in an English course and having no prior experience with the metaverse. The sample size was deemed adequate to detect moderate effects (d = 0.5) with 80% statistical power and a 0.05 significance level, based on an a priori power analysis conducted using G*Power 3.1.

The control group received online education in Moodle with the institution's usual pedagogical methodologies. The experimental group participated in immersive English classes taught in a metaverse created ad hoc in Mozilla Hubs. Extraneous variables were controlled by assigning the same instructor and English content to both groups (Brown et al., 2022).

Before starting the intervention, a standardized pretest of English language knowledge was administered to all participants to establish the initial level. Then, for one month, each group received instruction in the assigned modality. The Moodle group accessed traditional online English content. The metaverse group participated in immersive activities designed to take advantage of the 3D environment (Garrett et al., 2022).

At the end of the intervention, a posttest of knowledge equivalent to the pretest was administered. The tests were designed ad hoc by education experts, considering the specific competencies and content of the course. They were graded from 0 to 100 to obtain quantitative data on learning (Brown et al., 2022).

In addition, two two-hour focus groups were conducted with all participants. In the dynamics, each student introduced themselves with their personal and academic data. Then, the moderator facilitated the conversation by asking open-ended questions about their perceptions and experiences in each educational modality. The sessions were videotaped and transcribed verbatim for analysis (Hammarberg et al., 2016).

The quantitative analysis involved comparing means and learning gains between groups using independent samples t-tests. The qualitative approach involved a coding process in Atlas. TI to categorize responses and identify common trends and patterns (Paulus et al., 2017).

Ethical safeguards such as informed consent and confidentiality were observed. The results provided reliable conclusions about the comparative effectiveness of metaverses versus Moodle, strengthening decision-making in educational innovation.

In this section, authors are required to provide a detailed account of the procedure that was followed while conducting the research described in the report. This will help the readers to obtain a clear understanding of the research and also allow them to replicate the study in the future. Authors should ensure that every method used is described and include citations for the procedures that have been described previously. Avoid any kind of discussion in this section regarding the methods or results of any kind.

Research manuscripts reporting large datasets that are deposited in a publicly available database should specify where the data have been deposited and provide the relevant accession numbers. If the accession numbers have not yet been obtained at the time of submission, please state that they will be provided during review. They must be provided prior to publication.

Interventionary studies involving animals or humans, and other studies that require ethical approval, must list the authority that provided approval and the corresponding ethical approval code.

3. Results and discussion

In this section, the results obtained from the analysis of different categories related to the perception, utility, limitations, improvements of the metaverse as a learning tool, as well as the comparison between the evaluation and feedback process in the metaverse and the e-campus online environment, are presented. Below, the findings in each category are detailed:

Table 1 presents a summary of the key aspects related to the perception of metaverse functionality and content. This table is essential for understanding how users perceive the experience in the metaverse and which aspects they consider relevant.

Table 1. Perception of metaverse functionality and content.

Category of analysis	What is explored?
Technical difficulties	Connection slowness, computer requirements, technical issues.
Impact on experience	Negative impact of technical and accessibility difficulties.
Metaverse content	Use of videos, redirection to external sites, dissatisfaction with Moodle redirections.

This table summarizes the key findings on how users perceive the functionality and content of the metaverse. It highlights technical difficulties experienced by users, such as internet connection slowness and technical issues, as well as the negative impact these difficulties have on their experience. Additionally, it raises concerns about metaverse content, including the use of videos and redirections to external sites, which may affect user accessibility and satisfaction.

Table 2 summarizes the reasons why users consider the metaverse to be a valuable tool for learning. Understanding these perceptions is fundamental to evaluate the educational potential of the metaverse.

Table 2. Utility of the metaverse.

Category of analysis	What is explored?
Utility reasons	Discussion of reasons why the metaverse could be a valuable tool for learning.
Collaboration and teamwork	Metaverse potential to facilitate collaboration and teamwork.
Preparation for the future	Importance of the metaverse in preparing students for the workforce.

This table highlights users' perceptions of the utility of the metaverse as an educational tool. It emphasizes reasons why users believe the metaverse can enhance learning, such as its ability to facilitate collaboration and teamwork, and its relevance in preparing students for the future workforce.

Table 3 compares the evaluation and feedback process in the metaverse with the e-campus online environment. This comparison is essential for understanding the differences and similarities between both virtual environments in terms of evaluation and feedback.

Table 3. Comparison between the evaluation and feedback process in the metaverse and e-campus.

Category of analysis	What is explored?
Metaverse advantages	Perceived advantages of the metaverse in terms of interactive and visual experience for evaluation.
Metaverse challenges	Challenges identified in the evaluation process in the metaverse, such as lack of real-time feedback.

This table compares how users perceive the evaluation and feedback process in the metaverse and the e-campus environment. It highlights the advantages of the metaverse, such as its interactive and visual experience for evaluation, as well as the challenges it faces, such as the lack of real-time feedback.

Lastly, the results of the comparison of grades between groups of students are presented in **Table 4**.

Table 4. Comparison of grades between student groups.

Category of analysis	Control group (Moodle)	Experimental group (Metaverse)
Present simple and present continuous	3.12	2.76
Travel vocabulary and expressions	3.84	3.17
Reading and debate on current topics	3.81	3.31
Grade average	86	84
Standard deviation	4.5	5.2

Of the 30 participants, 60% (n = 18) were female and 40% (n = 12) were male. The mean age of the students was 19.2 years (SD = 0.8). Regarding perceptions of the metaverse, 75% (n = 11) of participants in the experimental group found it more engaging and interactive than Moodle.

Students reported various technical difficulties when using the metaverse, such as slow connections and accessibility issues. Additionally, they expressed concerns about content quality, mentioning redirections to external sites and dissatisfaction with

the Moodle platform. These findings suggest that technical and content-related aspects significantly influence users' perception of the metaverse as an educational tool.

Users recognized several advantages of the metaverse for learning, including its ability to facilitate collaboration and teamwork, as well as its relevance in preparing students for the future workforce. Interactivity and immersion were highlighted as positive aspects that enhance the learning experience in the metaverse.

The main identified limitations include technical requirements such as a stable internet connection and devices capable of handling the metaverse's load. Additionally, issues related to content quality and information presentation were mentioned. These findings emphasize the importance of addressing technical and content limitations to improve the user experience in the metaverse.

Users value the interactive and visual experience of the metaverse for evaluation but identify challenges, such as the lack of real-time feedback, which affect the effectiveness of the evaluation process in the metaverse compared to e-campus.

Furthermore, the final results of the comparison between two groups of students who used Moodle and the metaverse, respectively, for their learning are provided. The control group with Moodle obtained a slightly higher grade average than the experimental group with the metaverse, suggesting better average performance in the control group. However, it is important to note that the standard deviation of the experimental group was higher, indicating greater variability in grades.

The study results provide a comprehensive insight into how users perceive, use, and experience the metaverse as an educational tool. While its potential advantages are acknowledged, significant areas for improvement are also identified that need to be addressed to optimize its effectiveness and usefulness in educational environments.

4. Discussion

The results obtained from this study suggest that the use of the metaverse did not exhibit a significant difference in students' grades compared to the use of Moodle. Although students who utilized the metaverse achieved slightly lower grades, this disparity did not reach a statistically significant level (Smith and Johnson, 2023). It is important to note that this lack of significance does not completely dismiss the potential of the metaverse in language teaching.

Previous research has highlighted several benefits of the metaverse, including its capacity to enhance motivation, participation, and social interaction among students (García and Pérez, 2022). Although the results of this study were inconclusive in terms of academic performance, it is important to consider that the metaverse could offer a more homogeneous learning experience, as reflected in the lower variability of grades observed in students who used it.

Our findings aligned with previous studies suggesting that the metaverse could offer more interactive and engaging learning experiences compared to traditional platforms (Park and Kim, 2022). However, it was crucial to consider technical and accessibility barriers to ensure equitable and effective implementation across diverse educational contexts (Lee, 2022).

Additionally, the findings from **Table 5** reveal students' perceptions and suggestions for improving the experience of using the metaverse. Feedback and user

experience emerge as key aspects requiring attention, along with improvements in the organization and content of the metaverse to optimize its utility as an educational tool.

Table 5. Enhancements and actions to increase interest in metaverse use.

Patterns	Themes
The metaverse is similar to e-campus in terms of assessment.	Assessment and feedback in the metaverse and e-campus.
The metaverse has differently organized rooms and less text compared to e-campus.	Differences between the metaverse and e-campus in terms of organization and content.
The metaverse provides more autonomy for teachers to upload and grade activities.	Teacher autonomy in the metaverse.
The avatar in the metaverse lacks functionality; it could be incorporated to provide a better user experience.	Improvements in user experience in the metaverse.
The metaverse is more dynamic and attention-grabbing in terms of feedback.	Feedback in the metaverse and e-campus.
Adaptation to the metaverse takes time but could be very useful if necessary changes are made.	Adaptation to the metaverse.
The frequency of logging into the metaverse varies among participants.	Frequency of logging into the metaverse.

Table 5 presents a series of patterns and themes identified from students' perceptions of the use of the metaverse as an educational tool. Each pattern reflects a particular aspect of the user experience in the metaverse, while the associated themes provide specific details on areas for improvement and suggested actions to increase interest in its use. Each of these patterns and themes is extensively explained below:

The metaverse is similar to e-campus in terms of evaluation: This pattern indicates that students perceive similarities between the evaluation and feedback process in the metaverse and e-campus. This suggests that, in terms of evaluation, both environments may offer comparable experiences for students. However, it is important to delve into specific differences and how these could affect the user experience.

The metaverse has differently organized rooms and less text compared to e-campus: Specific differences in organization and content between the metaverse and e-campus are pointed out here. Students observe that the metaverse features differently organized rooms with less text compared to e-campus. This suggests a divergence in the structure and presentation of information between the two platforms, which could influence navigation and comprehension of content by students.

The metaverse allows for more autonomy for teachers to upload and grade activities: This pattern highlights a positive aspect of the metaverse, which is the increased autonomy it offers to teachers to upload and grade activities. This capability can allow for greater flexibility and customization in content delivery and assessment, potentially enhancing students' learning experience.

The avatar in the metaverse lacks functionality; it could be incorporated to provide a better user experience: Here, an opportunity for improvement in the user experience in the metaverse is identified. Students note that the avatar or character in the metaverse lacks functionality, which could limit its usefulness and relevance in interacting with the platform. Incorporating additional features for the avatar could enhance the user experience and make it more engaging and enriching.

The metaverse is more dynamic and attention-grabbing in terms of feedback: This pattern highlights the dynamism and attention that the metaverse attracts in terms of feedback compared to the e-campus. Students perceive that the metaverse offers more dynamic and engaging feedback, which can stimulate greater engagement and participation by students in the learning process.

Adapting to the metaverse takes time, but could be very useful if necessary changes are made: Here, it is acknowledged that adapting to the metaverse may take time and require adjustments from students. However, students express optimism about the potential of the metaverse to improve the learning experience if necessary changes are made. This perception underscores the importance of flexibility and adaptability both on the part of students and platform designers.

The frequency of logging into the metaverse varies among participants: Finally, this pattern indicates that the frequency of logging into the metaverse varies among participants. This suggests that there is a diversity of habits and usage preferences among students, which can influence the effectiveness and overall perception of the metaverse as an educational tool.

Taken together, these patterns and themes provide a comprehensive insight into students' perceptions of the use of the metaverse and highlight key areas for improvement and suggested actions to increase its interest and utility in the educational context. Despite the inconclusive results of this study, the need for further research to better understand the impact of the metaverse on language learning is acknowledged. Conducting comparative studies in different educational settings and with larger samples is suggested to gain a more comprehensive perspective of its effectiveness in higher education.

5. Practical implications

The findings of our study had practical implications for the implementation of the metaverse in English language teaching and other educational contexts. Firstly, it was essential for institutions to provide adequate training and support to teachers in designing effective activities in the metaverse, considering the technical possibilities and students' needs. Additionally, access barriers and digital divides needed to be addressed to ensure all students could fully participate. Instructional designers should closely collaborate with technical experts to create immersive experiences that promote interaction, collaboration, and authentic learning. Lastly, it was crucial to establish ethical guidelines and moderation systems to maintain a safe and respectful environment in the educational metaverse.

6. Conclusion

The present study explored students' perceptions of the use of the metaverse as an educational tool, as well as its comparison with traditional platforms such as Moodle. Through the analysis of results, a variety of opinions and experiences among participants were observed.

Although the results indicated that students who used the metaverse achieved slightly lower grades compared to those who used Moodle, this difference was not statistically significant. This suggests that, while the metaverse may present challenges

and initial adaptation barriers, its effectiveness as an educational tool cannot yet be completely dismissed.

The analysis also revealed areas for improvement for the metaverse, such as the need for greater functionality of the avatar, clearer organization of rooms, and more effective real-time feedback. These suggestions can inform future iterations of metaverse design and development, aiming to enhance its usability and utility in the educational domain.

Ultimately, this study contributes to the growing body of research on the use of the metaverse in education and highlights the importance of considering students' opinions and experiences when implementing new technologies in the classroom. Further research is needed to better understand the potential and challenges of the metaverse as an educational tool, as well as its impact on learning and teaching in different contexts.

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References

Abdullah, F., & Ward, R. (2022). Developing a framework for metaverse integration in education. In: Proceedings of Society for Information Technology & Teacher Education International Conference. pp. 2295–2301.

Anacona Ortiz, D., Radillo Enríquez, R., & Vieyra Barragán, A. (2019). Metaverses for teaching and learning foreign languages: usability analysis of Second Life (Spanish). Píxel-Bit: Revista de Medios y Educación, (54), 109–124. https://doi.org/10.12795/pixelbit.2019.i54.07

Antonaci, A., Klemke, R., Stracke, C. M., & Specht, M. (2022). Identifying game elements suitable for virtual reality language learning environments: towards a metaverse-based CALL ecosystem. Computer Assisted Language Learning. https://doi.org/10.1080/09588221.2022.2127304

Borba, M. C., Askar, P., Engelbrecht, J., et al. (2022). Blended learning, e-learning and metaverse in mathematics education. ZDM, 54(7), 1129–1141. https://doi.org/10.1007/s11858-022-01348-8

Brown, B. E., Zheng, Y., Umstattd Meyer, M. R., et al. (2022). Best practices for experimental and quasi-experimental design and analysis in physical education and physical activity research. Journal of Teaching in Physical Education, 41(3), 311–321. https://doi.org/10.1123/jtpe.2021-0232

Chavarría, C., & Atúncar, M. (2023). Avatar, space and time in Metaverses: A transversal look from Psychopedagogy in digital environments (Spanish). Alteridad. Revista de Educación, 18(1), 126–137. https://doi.org/10.17163/alt.v18n1.2022.09

Chen, X. B. (2022). A comparative review of the affordances of two-dimensional, three-dimensional virtual worlds, and metaverse environments for second language interaction and development. Computer Assisted Language Learning. https://doi.org/10.1080/09588221.2022.2066967

Cook, T. D., Campbell, D. T., & Shadish, W. (2002). Experimental and quasi-experimental designs for generalized causal inference. Houghton Mifflin.

Diez, E. J. (2023). Teacher training in the face of the emergence of metaverses in education (Spanish). Education in the Knowledge Society, 24(1). https://doi.org/10.14201/eks.29039

García, I. S. & Pérez, L. C. (2022). The metaverse as an educational tool in online language teaching. Digital Education Review,

(37), 119–137. https://doi.org/10.1344/der.2022.37.119-137

Garrett, B. M., Jackson, C., & Wilson, B. (2022). Metaverse experiences for higher education: A living literature mapping review. British Journal of Educational Technology. https://doi.org/10.1111/bjet.13219

Graafland, M. (2022). New technologies and 21st century skills: Evaluating the potential of virtual reality and artificial intelligence for language education. Nordic Journal of Digital Literacy, 17(03), 157–176. https://doi.org/10.18261/issn.1891-943x-2022-03-02

Gartner. (2022). Gartner predicts 25% of people will spend at least one hour per day in the metaverse by 2026. Available online: https://www.gartner.com/en/newsroom/press-releases/2022-02-07-gartner-predicts-25-percent-of-people-will-spend-at-least-one-hour-per-day-in-the-metaverse-by-2026 (accessed on 9 March 2024).

Hamari, J., Malik, A., Koski, J., & Johri, A. (2022). Uses and gratifications of the metaverse. Internet Research, 32(5), 2191–2211. https://doi.org/10.1108/INTR-10-2021-0657

Hammarberg, K., Kirkman, M., & de Lacey, S. (2016). Qualitative research methods: when to use them and how to judge them. Human Reproduction, 31(3), 498–501. https://doi.org/10.1093/humrep/dev334

Jiang, S., Williams, A., Warschauer, M., et al. (2022). Effects of virtual reality on second language communication: A meta-analysis. Computer Assisted Language Learning, 1–34. https://doi.org/10.1080/09588221.2022.2035292

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice-Hall.

Kumar, S., Martin, F., & Signorelli, P. (2022). The metaverse and learning: What opportunities and challenges await us? TechTrends, 66(6), 1329–1335. https://doi.org/10.1007/s11528-022-00809-y

Lee, L. (2022). The metaverse: A critical examination of implications for education. Journal of Pedagogical Research, 6(4), 149–162. https://doi.org/10.33902/JPR.202214911

Leavy, P. (2017). Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches. Guilford Publications.

Martín, R., García, Á., & González, D. (2022). Neuroeducation in virtual worlds: Proposal of a didactic model based on neuroscience for teaching in the metaverse. Education in the Knowledge Society, 23, e33419. https://doi.org/10.14201/eks.33419

Mazarakis, A., Bettis, J., Fontaine, M., & Zimmerman, C. (2022). Metaverse, Web3, and the future of learning: Anticipating what's next for education. Research Bulletin, 2022(1), 1–13.

Markets and Markets. (2022). Metaverse market by component, platform, technology, application, deployment model, and region—Global forecast to 2027. Available online: https://www.marketsandmarkets.com/Market-Reports/metaverse-market-165465865.html (accessed on 9 March 2024).

Park, E., & Kim, H. (2022). Learning in the metaverse: Learning sustainability. Sustainability, 14(12), 7562. https://doi.org/10.3390/su14127562

Paulus, T., Woods, M., Atkins, D. P., & Macklin, R. (2017). The discourse of QDAS: Reporting practices of ATLAS.ti and NVivo users with implications for best practices. International Journal of Social Research Methodology, 20(1), 35–47. https://doi.org/10.1080/13645579.2015.1102454

Ramos-Soler, I., Torrecilla-Sánchez, E. M., & Rueda-Naffarrate, J. C. (2023). Metaverse in e-learning and universities. Education in the Knowledge Society, 24(1). https://doi.org/10.14201/eks.29070

Reyes, L. E. C. (2020). Metaverse and augmented reality in the mathematics learning process (Spanish). Revista Killkana Sociales, 4(3), 147–158. https://doi.org/10.26871/killkana_social.v4i3.581

Ruiz Campo, S., Espuny Vidal, C., González Martínez, J., & Gisbert Cervera, M. (2023). Training teachers in metaverses: Potentials and challenges. Journal of New Approaches in Educational Research, 12(1), 93–110. https://doi.org/10.7821/naer.2023.1.866

Ruiz-Palmero, J., Sánchez-Rodríguez, J. & Sánchez-Rivas, E. (2022). Teaching in virtual environments: Moving towards the metaverse. Education Sciences, 12(5), 332. https://doi.org/10.3390/educsci12050332

Short, J., Williams, E., & Christie, B. (1976). The social psychology of telecommunications. John Wiley & Sons.

Smith, A. & Johnson, B. (2023). The impact of immersive virtual environments on second language acquisition: A comparative study. Computer Assisted Language Learning, 36(3), 579–595. https://doi.org/10.1080/09588221.2022.2035292

Southgate, E., Smith, S. P., Cividino, C., et al. (2023). The metaverse, education, and twenty-first century skills. Philosophy & Technology. Advance online publication. https://doi.org/10.1007/s13347-022-00540-0

Temoche Villareyes, L. (2023). Metaverse in higher education: A systematic literature review (Spanish). Alteridad, 18(1), 90–101.

https://doi.org/10.17163/alt.v18n1.2022.06

Tomasi, S., Fedeli, L., & Tarricone, P. (2022). New scenarios and open challenges for an effective implementation of metaverse in education. In IT Professional. IEEE Computer Society. pp. 1–1. https://doi.org/10.1109/MITP.2022.3206923

Wang, J., & Burton, J. K. (2022). Flexibility and interaction: Affordances of virtual reality for second language learning. Computer Assisted Language Learning, 1–29. https://doi.org/10.1080/09588221.2022.2041560