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Teaching Strategies in The Metaverse for Children with Psychomotor Deficiencies in Early Childhood Education: An Innovative Approach to Motor and Cognitive Development

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ABSTRACT

The metaverse has currently become an educational tool of great relevance, which allows the design of immersive and adapted virtual environments to promote the cognitive and motor development of children with psychomotor deficiencies. The present research carries out a systematic review of the literature, under the PRISMA methodology, through questions to identify recent studies on the Metaverse in Early Childhood Education and its feasibility in the teaching-learning process using specific search operators (AND, OR, NOT) in three phases. In the first phase, according to the number of articles, 180 articles were identified, of which 35 duplicate documents were eliminated as the first step of the second phase, leaving 29 according to their eligibility. Finally, in the last phase, according to the number of articles related to the topic of the Metaverse in Early Childhood Education; Psychomotor and cognitive development, 20 articles were obtained. Therefore, it is determined that the Metaverse allows multisensory and interactive experiences that promote symbolic learning. These technologies promote inclusion by allowing content and activities to be adapted to the specific abilities of each child.

Keywords: Metaverse, psychomotor and cognitive.

1. INTRODUCTION

In Ecuador, inclusive education has taken on special relevance in recent years, and especially in those reforms aimed at guaranteeing equity, however, gaps persist in the care of children with psychomotor deficiencies in early education. As a result of the Covid-19 pandemic, the use of digital technologies was promoted, including augmented reality and interactive resources. In this context, the Metaverse is presented as an immersive three-dimensional environment with high pedagogical potential, especially for motor and cognitive stimulation in early childhood (Bizel, 2023). However, the metaverse is defined as a shared three-dimensional digital environment (Stephenson, 1992). It is transforming training through immersive experiences that favor multisensory interaction and critical reasoning. Given these progresses, it is crucial that teachers are trained to incorporate technological resources in an ethical and pedagogically grounded way. Only in this way will it be possible to transform the educational process from early childhood, committing to ensure that each child, without exception, can access meaningful, personalized and inclusive learning (Avalos & Padilla, 2024; UNESCO, 2022; Ministerio de Educación, 2024).

The objective of the study was to analyze the pedagogical potential of the metaverse as a tool to improve teaching-learning processes in early childhood children with psychomotor deficiencies, in terms of methodology, the PRISMA approach was used to proceed to carry out a systematic review of the scientific literature published between 2020 and 2025, which included studies in Spanish and English, open access focused on the use of the metaverse or immersive technologies applied to early education and inclusion (Ferreira, 2020; Mayorga, 2024).

In addition, the use of the Metaverse in early education environments helps to simulate several safe learning contexts, where children with psychomotor disabilities can explore, interact and thus develop motor skills in a playful and structured way, these virtual spaces offer the possibility of adapting stimuli according to individual needs, generating

greater inclusion and active participation of children, activating not only physical development but also the cognitive part in order to strengthen self-esteem and autonomy (González & Ramos, 2020; Sandoval & Pérez, 2021).

The virtual environment provides a field of 3D modeled objects in order to generate an industrial environment, thus linking the external signals of the process control and pointing out in the indicators of the scope and the communication protocols, in order to optimize resources and promote results (Freire, 2023).

Despite the implementation of these technologies, certain clear educational policies are required, under the accompaniment of interdisciplinary teams, therefore it is essential that the design and execution of these tools consider criteria of accessibility, equity and cultural relevance, particularly in rural sectors that are more vulnerable, only to have a comprehensive and inclusive approach in order to close these existing gaps in order to guarantee that the metaverse is not simply a tool but that it promotes those spaces that are alien to reality (López, 2023; Méndez, 2021; Sánchez, 2024).

2. METHODOLOGY

The PRISMA methodology was used to carry out a systematic review of the literature between 2020 and 2025, studies in Spanish and English were included, focused on the use of the Metaverse or immersive technologies applied to early education and inclusion, duplicate articles, without peer review or not relevant to the educational level were excluded, the search was carried out in Web of Science, MDPI, Scopus, Google Scholar, SciELO, Dialnet and Redalyc (Hernández, 2014). It provides benefits for both teachers and students, as it provides a broader vision of how immersive technologies can facilitate more dynamic and inclusive teaching-learning processes; For the teacher, it implies the possibility of designing innovative educational experiences that meet diverse needs and learning styles, promoting the motivation and active participation of students, for the student, the use of these technologies offer interactive and personalized learning environments that can improve understanding, retention of information and the development of cognitive and socio-emotional skills in initial and diverse contexts.

2.1. Research Questions

Questions have been asked to explore how the metaverse can enhance the teaching-learning processes in Early Childhood Education children.

Table 1 Research Questions

Code	Research Questions
Question 1	What are the teaching strategies for supporting children with psychomotor impairments?
Question 2	What are the effects of the metaverse on the motivation of children in Early Childhood Education?
Question 3	How do virtual environments adapt to the educational needs of children at the Initial level?
Question 4	What is the contribution of virtual environments to the motor and cognitive development of children in early childhood?

2.2. Document Search

From 2020 to the present, a systematic compilation of documents related to the use of the Metaverse in the educational field has been carried out, for the documentary search in scientific databases, combinations of key terms were applied such as: ("teaching strateg*" OR "educational strateg*" OR "pedagogical approach*" OR "instructional method*") AND ("meta

verse" OR "virtual environment*" OR "immersive environment*" OR "augmented reality" OR "virtual reality" OR "XR" OR "3D environment*") AND ("psychomotor deficien*" OR "psychomotor disab*" OR "motor disab*" OR "developmental disab*" OR "special need*") AND ("early childhood education" OR "preschool" OR "kindergarten" OR "primary education" OR "infant education") AND ("cognitive development" OR "motor development"). This search strategy made it possible to identify specific and relevant studies for the object of study.

2.3. Selection of articles

In the first phase, articles were identified that were more relevant to the topic, but above all of great impact according to the desired research. For this reason, the first step of the second phase was to determine the eligibility criteria. See Table 2

Table 2 Eligibility Criteria

Criteria	Description
Study design	Articles whose main objective is the integration of the Metaverse by proposing an innovative perspective for motor and cognitive development were selected, in addition those documents that had nothing to do with the subject were discarded.
Time Range	Articles published between 2020 and 2025 were prioritized and those that did not meet the established criteria were excluded
Language	Articles in English and Spanish were considered in order to broaden the spectrum of analysis and obtain a broader vision of the topic
Publication status	Only officially published articles that had a DOI (Digital Object Identifier) were included

During the process, they were grouped into four thematic categories, with these terms a search equation was constructed through the use of Boolean connectors (AND, OR, NOT), which allowed a specific and effective search to be carried out in academic databases. The main objective was to ensure that each element is correctly located and related to the thematic lines of study, it was evaluated if each article adequately responded to the questions raised, framed in the STEM approach and its link with the metaverse. Figure 1 represents the selection process of the articles, through the PRISMA 2009 flowchart. After applying the search criteria, 20 articles were selected that were directly aligned with the objectives of the research.

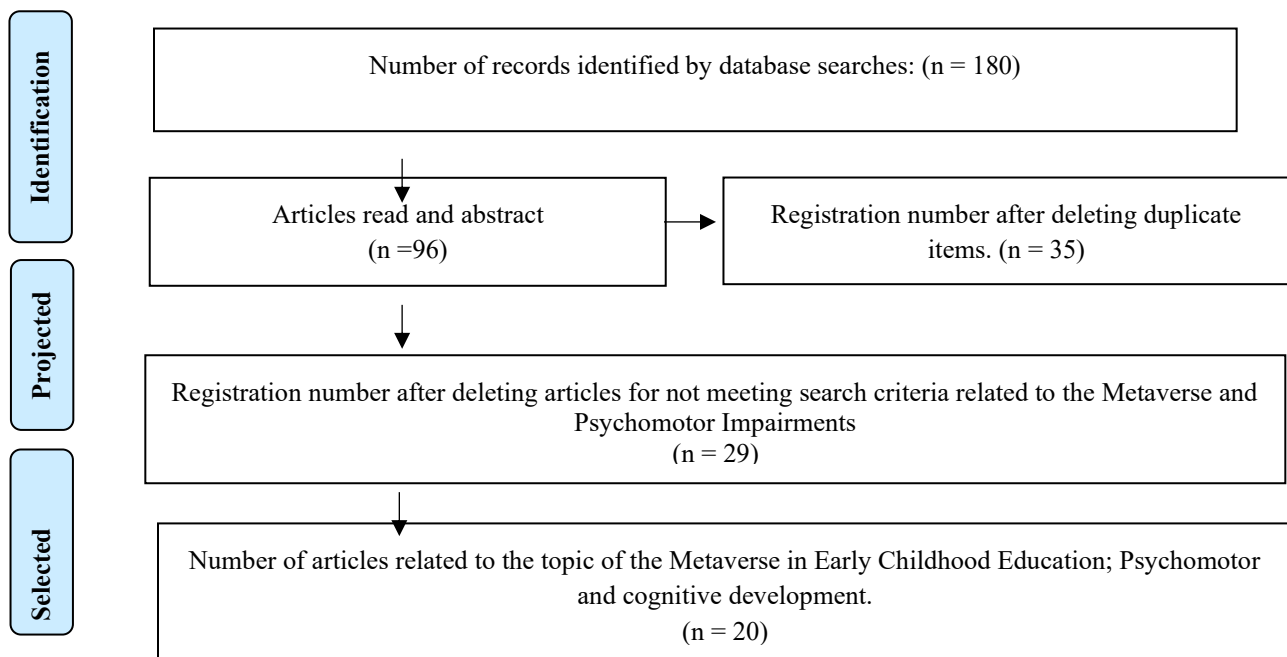
Figure 1 PRISMA 2009 Flowchart

Figure 1. PRISMA flowchart: the twenty articles were selected according to content and relationship with the research topic, verifying that the topic is related to the Metaverse for children with psychomotor impairments.

Figure 2 Keyword Concurrency

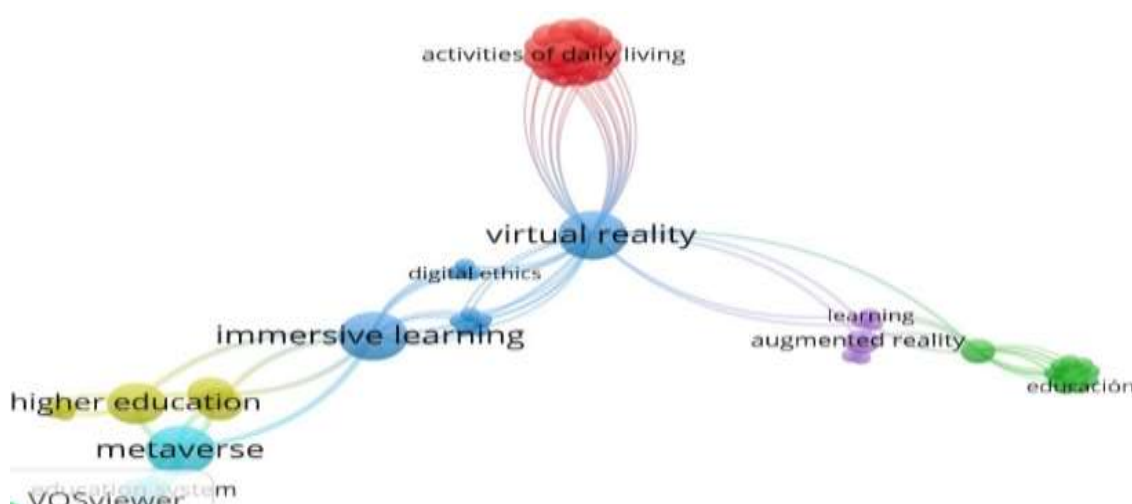
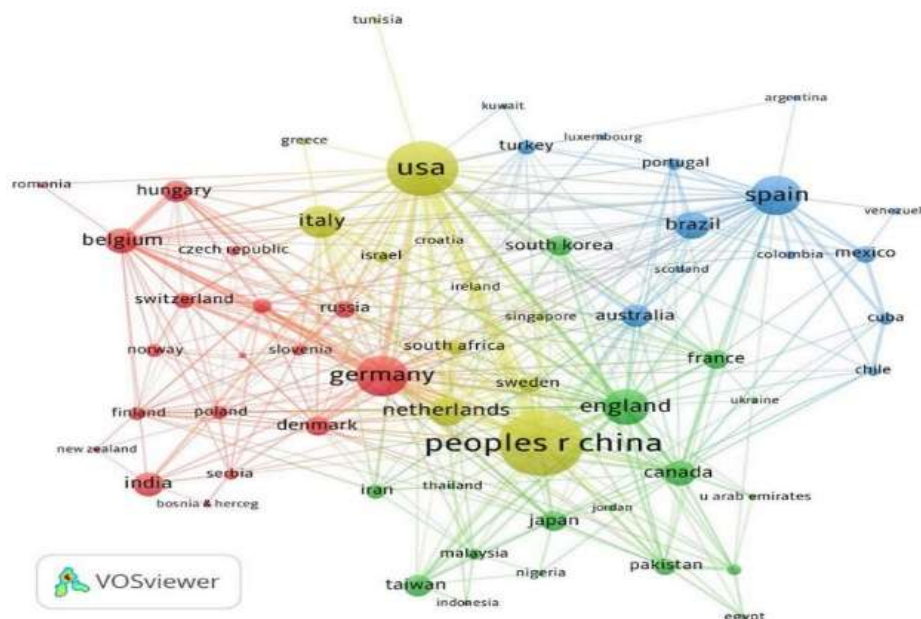


Figure 3 Keyword concurrence by country



Likewise, figures 2 and 3 present an analysis of keyword concurrence carried out using the VOSviewer software, which allowed the identification of the most frequent thematic relationships between the selected documents. Among the most recurrent keywords are: teaching strategies, metaverse, psychomotor deficiencies, motor and cognitive development, virtual environments, technology, early education, innovation strategies, curriculum development and teacher training.

Below is a synthesis of the documents classified into two categories: Proactive Education and Personalized Education, with their respective codes, titles, years of publication, reported improvements and source databases.

Table 3 Proactive Education

Code	Name	Year	% Reported Improvement	Databases
S1	Educational implications of incorporating contemporary interactive techniques into the curriculum.	2024	85%	Scopus
S2	Transform pedagogical practices through collaborative work.	2020	70%	Scopus
S4	The educational philosophy of "Learning-Oriented Teaching" in the Analects and its perspectives for the contemporary era.	2022	68%	Scopus

S6	Innovative pedagogical technologies in the educational system.	2022	80%	Scopus
S8	A proposal for a qualitative method for the study of strategy as a practice	2021	65%	Scopus
S9	Impact of a Spanish University Teaching Development Program on Teaching Approaches. Psychometric Properties of the s-ati-20 Scale	2021	70%	Redalyc
S10	Pedagogical models based on transversal digital competences in distance education: creation parameters.	2023	88%	Redalyc
S11	Artificial Intelligence - The Space of New Possibilities for Teacher Training	2019	77%	Redalyc
S19	Educational Strategies for the Development of Psychomotor Skills in Early Childhood Students: A Systematic Review	2024	85%	Redalyc
S20	Technological resources for learning in the framework of Ecuadorian inclusive education.	2024	80%	Scielo

Table 4 Personalized Education

Code	Name	Year	% Reported Improvement	Databases
S3	Impact of the use of Virtual Reality glasses on student learning: an empirical study	2025	75%	Scopus
S5	Immersive education in the metaverse: bridging the gap between technology and social collaboration	2024	72%	Scopus
S7	Impact of the use of Virtual Reality glasses on student learning: an empirical study	2025	74%	Dialnet
S12	Heritage education experience supported by augmented reality	2021	82%	Redalyc
S13	Augmented reality in the educational sphere of the undergraduate degree in early childhood education. Case study	2017	60%	Redalyc
S14	Systematic Review on Collaborative Learning in Virtual Reality, Augmented Reality and Mixed Reality	2025	90%	Scopus
S15	What will the education of the future be like? How have the metaverse and Extended Reality affected higher education systems?	2024	92%	Scopus
S16	Cognitive load and mixed reality (augmented and virtual)	2023	93%	Scopus
S17	The Metaverse as a Learning Environment: Some Considerations	2023	55%	MDPI
S18	Immersive Learning in the Metaverse: A Review of the Evidence on Pedagogical Effectiveness and Implementation Gaps in Higher Education	2024	60%	Scopus

Results

2.4. Literature review

From the research carried out, it is determined that the Metaverse allows multisensory and interactive practices that promote symbolic, critical, and imaginative learning in the initial stage (González & Ramos, 2020). These technologies favor inclusion by allowing content and activities to be adapted to the specific abilities of each child.

2.5. Article details

In Figure 4, the objective was to visualize and compare the average educational improvement reported in research in different academic databases in order to identify which ones present studies with greater pedagogical impact. To do this, the articles were grouped according to their source of publication and the averages of the percentages of reported educational improvement were calculated. These results were represented by a pie chart that allowed a clearer observation of the relative proportion of improvement attributed to each base.

This visual representation does not seek to prioritize the bases by their general quality, but to offer a perspective on the average impact of the educational research they contain. Thus, the analysis contributes to orienting teachers,

researchers, and decision-makers towards sources that, on average, have reported greater pedagogical effectiveness in their findings.

Figure 4 Database for information collection.

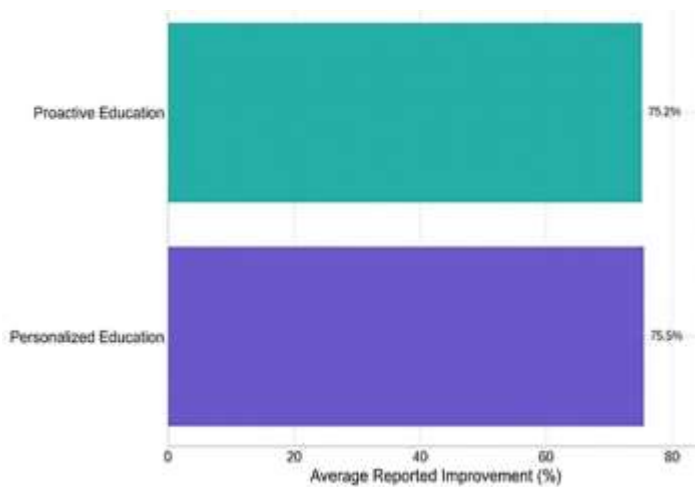
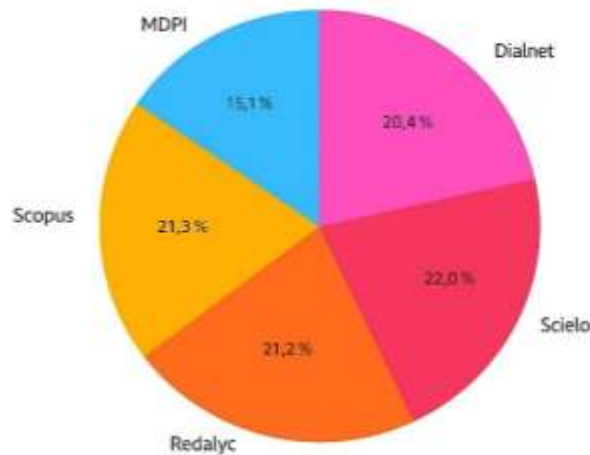


Figure 5 Distribution of articles according to database

Analysis of the two figures

Figures 4 and 5 allow us to visualize the relevance provided by the different databases used in the systematic review. The predominance of Scopus is observed, which provides the largest proportion of articles, consolidating itself as a solid and rigorous source for accessing updated academic research on the Metaverse, immersive technologies and their application in educational and inclusive contexts. This leadership can be attributed to the wide thematic coverage, its international scope and the high standards of editorial quality required for its publication.

In second place, Redalyc contributes 31.6% of the articles, highlighting its crucial role as a repository of scientific production in Latin America, its focus on open science facilitates access to contextualized and relevant research for the region.

Although Dialnet and SciELO are underrepresented, their contribution is no less significant, these repositories offer articles with more specific regional approaches, particularly in areas such as psychopedagogy and didactic innovation, enriching the analysis from a complementary perspective. While Scopus provides a global and diverse vision, Redalyc, SciELO and Dialnet bring contextual depth and cultural relevance to the study, therefore the combination of these sources guarantees a more balanced and representative analysis of the educational reality, especially in relation to the use of the metaverse in early childhood education as a pedagogical support tool.

2.6. Thematic and temporal distribution of the articles

Figure 5 shows the temporal distribution of proactive and personalized education publications, during the period analyzed, related to the topic of study.

2.7. Quantitative analysis: impact of educational technologies

The results indicate that most studies report improvements between 70% and 90%, with a particularly high concentration of 80-85%; this trend reveals a positive impact of the technologies applied in educational environments.

3. Discussion

3.1. Answers to Research Questions

Q1: What teaching techniques are effective in supporting children with psychomotor difficulties in early education?

For children with psychomotor difficulties, they include multisensory methods that promote visual-motor coordination, such as the use of role-playing and technological play activities has been shown to be beneficial. Bismark (2023) reports that 62% of teachers implement role-playing to stimulate visual-motor coordination, while 45% use interactive applications to improve fine motor skills.

Q2: What impact does the metaverse have on children's motivation in early education?

The metaverse has shown a great positive effect on the motivation of children in early education.

Barráez & Herrera (2022) describe how the use of immersive and multisensory virtual environments offers the opportunity to generate interactive experiences in three dimensions that simulate reality, which can increase student motivation.

Q3: How are virtual environments adapted to the educational needs of children at the Initial level?

Virtual environments are molded according to the educational requirements of infants in the initial stage, through the personalization of the material, guaranteeing access by providing instant answers, according to the research. Martínez & Pérez (2023), these adaptations are crucial to maximize learning in virtual contexts.

Q4 What is the contribution of virtual environments to the motor and cognitive development of children in early childhood?

Digital environments play a crucial role in the physical growth of young children through specific activities, they favor the development of both physical and cognitive skills, giving children the opportunity to explore, learn within a safe and controlled environment.

4. Conclusions

- The use of the Metaverse as an educational tool represents a more efficient, innovative and promising alternative with the purpose of stimulating motor and cognitive development in children with psychomotor deficiencies at the initial education level.
- Immersive experiences in virtual environments allow for greater active participation by the child, stimulating their adaptation to learning rhythms and thus facilitating the improvement of both motor and cognitive skills through interactive play.
- The implementation of Metaverse pedagogical strategies favors the personalization of the teaching-learning process, increasing the motivation, autonomy, and self-esteem of students with special needs and who require prompt attention.
- The integration of various technologies in the classroom of children who are just starting their student life requires adequate planning, teacher accompaniment and having a technological infrastructure that guarantees both equity and accessibility for all children.

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