

THE USE OF TECHNOLOGIES IN COLLABORATIVE TEACHING:
INTERNATIONAL PERSPECTIVES

*O USO DAS TECNOLOGIAS NO ENSINO COLABORATIVO: PERSPECTIVAS
INTERNACIONAIS*

*EL USO DE LAS TECNOLOGÍAS EN LA ENSEÑANZA COLABORATIVA:
PERSPECTIVAS INTERNACIONALES*



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How to reference this article:

FERRAZ, M.; FRANÇA, A.; VILARONGA, C. A. R. The use of technologies in collaborative teaching: international perspectives. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 19, n. 00, e024109, 2024. e-ISSN: 1982-5587. DOI: <https://doi.org/10.21723/riace.v19iesp.2.18961>



| Submitted: 24/01/2024

| Revisions required: 21/02/2024

| Approved: 02/04/2024

| Published: 06/09/2024

Editor: Prof. Dr. José Luís Bizelli

Deputy Executive Editor: Prof. Dr. José Anderson Santos Cruz

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ABSTRACT: Technology permeates nearly every sphere of humanity, and educational practices demand innovations to meet the individual needs of all students. However, its integration into education is not always effective due to challenges such as limited financial resources and resistance to change in pedagogical practices. Thus, how is technology applied in collaborative teaching, especially in heterogeneous environments with students in special education programs (PEE)? This research aimed to analyze scientific productions regarding the use of Digital Information and Communication Technologies (ICT) in teaching students in special education programs through practices based on collaborative teaching. The systematic review method was used to investigate international scientific documents, with a temporal cut-off of five years (2019-2023). The results indicated the promising potential of ICT in collaborative teaching for students in special education programs, but also revealed the need for further investment in research in this area.

KEYWORDS: Special education. Co-teaching. Digital Information and Communication Technologies

RESUMO: *A tecnologia permeia quase todas as esferas da humanidade, e as práticas educacionais demandam inovações para atender às necessidades individuais de todos os estudantes. Apesar disso, sua inserção na educação nem sempre é efetiva devido a desafios como escassez de recursos financeiros e resistência à mudança nas práticas pedagógicas. Destarte, como a tecnologia é aplicada no ensino colaborativo, especialmente em ambientes heterogêneos com estudantes público da educação especial (PEE)? Esta pesquisa objetivou analisar as produções científicas acerca do uso das Tecnologias Digitais da Informação e Comunicação (TDIC) no ensino de estudantes público da educação especial por meio de práticas com base no ensino colaborativo. Foi utilizado o método de revisão sistemática para investigar documentos científicos internacionais, com recorte temporal de cinco anos (2019–2023). Os resultados apontaram o potencial promissor das TDIC no ensino colaborativo para estudantes PEE, mas também revelaram a necessidade de mais investimentos em pesquisas nessa área.*

PALAVRAS-CHAVE: Educação Especial. Coensino. Tecnologias Digitais da Informação e Comunicação.

RESUMEN: *La tecnología permea casi todas las esferas de la humanidad, y las prácticas educativas demandan innovaciones para satisfacer las necesidades individuales de todos los estudiantes. Sin embargo, su inserción en la educación no siempre es efectiva debido a desafíos como la escasez de recursos financieros y la resistencia al cambio en las prácticas pedagógicas. Por lo tanto, ¿cómo se aplica la tecnología en la enseñanza colaborativa, especialmente en entornos heterogéneos con estudiantes de educación especial (PEE)? Esta investigación tuvo como objetivo analizar las producciones científicas sobre el uso de las Tecnologías Digitales de la Información y la Comunicación (TDIC) en la enseñanza de estudiantes de educación especial a través de prácticas basadas en la enseñanza colaborativa. Se utilizó el método de revisión sistemática para investigar documentos científicos internacionales, con un recorte temporal de cinco años (2019-2023). Los resultados señalaron el potencial prometedor de las TDIC en la enseñanza colaborativa para estudiantes de educación especial, pero también revelaron la necesidad de más inversiones en investigaciones en esta área.*

PALABRAS CLAVE: Educación especial. Coenseñanza. Tecnologías digitales de la información y la comunicación.

Introduction

School inclusion seeks to meet the educational needs of all students, regardless of their characteristics or abilities. This educational assumption aims to guarantee equal opportunities and the full development of each student, with the aim of promoting learning for all.

The context of school inclusion has as one of its landmarks the Brazilian Inclusion Law (Brazil, 2015), which in its article 27 establishes that education is a right of people with disabilities⁴ and must be guaranteed by an inclusive educational system at all levels, with the possibility of lifelong learning. This measure aims to guarantee access to education for the special education public (PEE) and promote the educational, social and professional inclusion of these individuals.

The legal provision in question reinforces the importance of guaranteeing access to quality education for PEE people, as well as the need to promote an inclusive educational environment, respecting differences and offering support for the full development of each individual. Furthermore, the possibility of lifelong learning highlights the importance of education as a continuous and permanent process for the personal and professional training and development of these individuals.

Within these supports that should be provided by the school, Specialized Educational Assistance (AEE) is offered:

III - pedagogical project that institutionalizes specialized educational assistance, as well as other services and reasonable adaptations, to meet the characteristics of students with disabilities and guarantee their full access to the curriculum under equal conditions, promoting the achievement and exercise of their autonomy (Brazil, 2015, our translation).

This service presupposes the performance of the special education teacher in the space of the regular school, however, according to the Special Education Policy (Brazil, 2008), it is understood that the space for this service to take place in the multifunctional resource room and after hours.

Co-teaching aims to join AEE in the context of the common room, in this partnership thinking about how to guarantee the curriculum on an equal basis for all students. Collaborative Teaching, which involves collaboration between special education and regular classroom teachers, is one of the proposals of some countries to promote the school inclusion of PEE

⁴ “Art. 2. A person with a disability is considered to be someone who has a long-term impairment of a physical, mental, intellectual or sensory nature, which, in interaction with one or more barriers, may obstruct their full and effective participation in society on equal terms with others. (Brazil, 2015).”

people, and is considered one of the most relevant. In Brazil, this has happened with local and recent policies (Vilaronga; Mendes, 2014, Capellini; Zerbato, 2019).

In contrast, the use of Digital Information and Communication Technologies (DIT) in education has become increasingly frequent in recent years, bringing with it new possibilities and challenges for educators and students. Technologies can help educators personalize learning for each student, considering their individual skills, needs and learning styles, and should be inserted into the school so that students can “understand, question, study and develop in the best way possible using these resources” (Pacitti; Tardin; Romero, 2022), ensuring that each student is challenged appropriately and can progress at their own pace.

According to Mercado's view (2002), the new TDIC have the potential to create new opportunities for education, which demands an innovative stance from the educator who must be willing to constantly update himself and explore the possibilities of technologies to offer innovative educational experiences, differentiated and more attractive learning.

Given this, a question arises about how technology is being used in collaborative teaching, in heterogeneous classrooms and with public special education students? From this perspective, the objective is to analyze scientific productions about the use of Digital Information and Communication Technologies in teaching public special education students through practices based on collaborative teaching.

Collaborative teaching and the use of TDIC

"Collaborative Teaching", co-teaching or "*Co-Teaching*", a term used in English, had its origins in the second half of the 20th century. During this period, education professionals in the United States and other developed countries began to question the effectiveness of traditional teaching models, especially in the early 1950s. These professionals sought a new approach that could provide a more inclusive educational environment and enriching for all students, including those with specific needs (Hanslovsky; Moyer; Wagner, 1969).

Bauwens, Hourcade and Friend (1989) described the Collaborative Teaching model at the end of the 1980s, highlighting some characteristics that differentiate this model from previous ones. In the Collaborative Teaching approach, the common room teacher and the Special Education teacher work together in the same classroom, establishing a direct partnership and sharing the same responsibilities in the educational process. This collaboration aims to educate a heterogeneous group of students, offering individualized support and guidance to those who need special attention.

The proposal redefines the role of special education teachers, who begin to act as support centered in the regular classroom instead of just offering services to remove PEE students from regular classrooms (Wood, 1998). Together they would work on planning, carrying out and evaluating teaching.

In this approach, special education teachers work together with other teachers at the school, collaborating to offer an inclusive and enriching educational environment for all students. The objective is to guarantee the full and effective participation of PEE students in all school activities, thus promoting academic and social development, valuing diversity and recognizing individual differences, seeking to provide all students with a quality education (São Paulo, 2021).

Some Brazilian municipalities have included co-teaching in AEE practices and recently the state of São Paulo incorporated it as a project. The Special Education Policy of the State of São Paulo, established in 2021, refers to Collaborative Teaching as a fundamental strategy to guarantee the inclusion of students eligible for special education services in regular classes in common education, this approach is an important guideline to promote inclusive culture in public schools. The implementation aims at articulating the special education teacher and the teachers in charge of regular classes, seeking to provide a more inclusive and quality education for all students (São Paulo, 2021).

Collaborative teaching is an educational practice that has gained prominence in inclusive education in regular education, being one of the most promising forms of collaboration to support the education of PEE students in regular classrooms (Capellini; Zerbato, 2019).

The use of TDIC can favor the practice of co-teaching, since with the internet and other digital resources, students have access to a large amount of information in real time, allowing them to expand their knowledge, in addition to assisting teachers in teaching according to the specific needs of each student (Pacitti; Tardin; Romero, 2022). According to Banell *et al.* (2016), access to information made possible by digital technologies can be the starting point for building knowledge. However, the use of these technologies may not be effective if they are not used properly.

For Wolff (2020), TDIC has a great impact on the economy, politics and society, being part of a culture that affects everyday school life and reshapes educational practices. TDIC are “a range of technological bases that enable, through equipment, programs and media, the association of different environments and individuals in a network, facilitating communication

between its members, expanding actions and possibilities” (Soares *et al.*, 2015, p. 3, our translation). It is part of “the convergent set of technologies in microelectronics, computing (software and hardware), telecommunications/broadcasting, and optoelectronics” (Castells, 2019, p. 67, our translation).

Furthermore, it can also make learning more interesting and engaging for schoolchildren by allowing them to use different media and content formats. This can help maintain your attention and motivation, making the learning process more enjoyable and effective (Gewehr, 2016). Technologies can facilitate collaboration between students and teachers and between teachers, allowing them to work on projects together, share ideas and feedback more efficiently, contributing to the development of important skills, such as teamwork and communication.

Method

For this study, of a descriptive-explanatory and basic nature, a bibliographic approach was used to conduct the analysis and investigation of international scientific documents available in three different databases. Under a five-year time frame (2019 – 2023), aiming to analyze the results of the period of the outbreak of the COVID-19 pandemic. This approach is fundamental for understanding transformations in the use of educational technology, providing *insights* into the pedagogical practices that were adopted before and after this disruptive event.

The selection of these platforms occurred due to their level of recognition by the scientific community and their respective areas of coverage or scope. The first of these is the database of the Periodicals Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES), a Brazilian platform that offers access to a large number of academic productions.

Another platform used is ERIC (Education Resources Information Center). It is a database maintained by the United States Department of Education's Institute of Education Sciences and covers a wide variety of topics related to this area, including educational policy, school administration, educational assessment, educational technology, among others.

Another database is *Scopus*, which allows access to a range of documents from different areas of knowledge in scientific journals considered to be of high impact, that is, those with great influence in the area of research in which they focus.

For the search, selection, structuring and consecutive analysis of the data generated on each of these platforms, the systematic review method was chosen, which is portrayed by

Donato and Donato (2019) as more profitable, when compared to traditional reviews consider this to be due to the fact that it is a rigorous and systematic approach to evidence synthesis. Furthermore, it involves a broad and structured search in the scientific literature, a careful selection of relevant studies, an assessment of the methodological quality of these studies, in addition to the synthesis of data to answer a specific research question.

The definition of the first stage, named as (i) research question, is considered essential by Galvão, Sawada and Trevizan (2004) and Donato and Donato (2019), since it is what gives direction to the chain of research actions. The strategy selected for this study is represented by the acronym PCC (Problem; Concept and Context). It is recommended for improving searches in retrieval systems, such as libraries and databases from different research contexts, improving the precision and relevance of results (Araújo, 2020).

In the first step, the researcher clearly defines the problem or question they want to answer. This includes identifying the main elements and key terms related to the research topic. The second step refers to identifying relevant concepts related to the previously defined problem so that it is possible to create a list of synonyms, alternative terms and/or related terms to help expand the search. Only in the last step will the investigator determine the context in which the search will be carried out, including specifying relevant sources, such as databases, books or articles.

Each of these acronym blocks is converted into a specific question to facilitate the process of extracting information from the guiding question which, translated into English and Spanish, becomes descriptors. These descriptors are keywords or specific terms that represent concepts relevant to the research topic that, combined with each other, together with the use of *Boolean operators*⁵, generate a syntax (specified in step iv) that is used to perform searches within each of the platforms (Araújo, 2020).

⁵ Boolean operators are connectors used to link the terms of interest in the search question, thus forming the search strategy as a whole. Each operator has a function, represented by *AND*, *OR* and *AND NOT* (Latorraca *et al.*, 2019).

Table 1 – Guiding Question.

Guiding question		How is technology used in collaborative teaching, in heterogeneous classrooms and with public special education students?			
STRATEGY		QUESTIONS	EXTRACTION	CONVERSION	COMBINATIONS
P	Population	Who makes up and what are the characteristics of the population to be researched?	Students with disabilities; Special Education Audience	<i>Students with disabilities;</i> <i>People with disabilities</i>	<i>Students with disabilities</i> <i>OR</i> <i>People with disabilities</i>
C	Concept	What is the central issue to be examined?	Collaborative teaching; Co-teaching; Technology.	<i>Collaborative teaching;</i> <i>Co-teaching;</i> <i>Technology</i>	<i>Collaborative teaching OR</i> <i>Co-teaching</i> <i>AND Technology</i>
C	Context	What specific details, or cultural factors, or geographic location, or gender issues, or racial issues, etc. Are they related to the population?	Time frame (2019-2023) Heterogeneous rooms; inclusive rooms	2019-2023 <i>Heterogeneous classrooms ;</i> <i>including classrooms</i>	2019-2023 <i>Heterogeneous classrooms</i> <i>OR</i> <i>including classrooms</i>

Source: Prepared by the authors (adapted from Araújo, 2020).

The guiding question is one of the most important steps in preparing a systematic review, as it defines the scope of the research and guides the other steps of the process. After extracting the terms that compose it, they are converted into English and organized to form part of the controlled and standardized vocabulary. After this systematization, inclusion and exclusion criteria (ii) were established according to the specificities necessary for the selection and delimitation of results. To be selected, therefore, documents must be indexed on database platforms from (a) international journals; (b) within the five-year period, between 2019 and 2023; (c) available in their entirety; (d) participants from the special education public. As exclusion criteria, it was determined that articles that (a) are outside the stipulated time frame will not be selected; (b) fragmented indexing or with restricted access; and, (c) those who stray away from topics related to collaborative teaching and technologies.

Step (iii) refers to the research strategy used to carry out the searches. For this to occur, the previous steps were respected, as well as the combination of descriptors for the pre-selection of materials in the databases. The organization of terms occurs based on a domain hierarchy determined from more general terms to more specific ones, according to the intention of the search, to try to achieve greater precision and comprehensiveness in the data obtained.

In table 2 it is possible to identify that, in the first instance, the descriptors related to “collaborative teaching/co-teaching” remain at the forefront, while the relationship with “technology” is what establishes a more specific parameter about the other area. Even though, for the purposes of this research, they are positioned in this way, there is the possibility of variation between the terms depending on the theme and the database used, with a certain malleability in their uses and functionalities.

Table 2 – Construction of Syntax in English.

ENGLISH	<i>(“Students with disabilities” OR “people with disabilities”) AND (“Collaborative Teaching” OR “Co-teaching”) AND technology</i>
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Source: Prepared by the authors.

In this way, after completing the searches, we move on to the next stage of the review, called article selection (iv). In this step, the documents collected in the previous steps were pre-evaluated, based on a preliminary reading of their respective titles and summaries, with the special education teacher working with the common room teacher as the prerogative. Studies that distance themselves from the pre-established proposal or theme were also excluded at this time. Those who were approved continue to read the material available in full.

This stage organized the results from the perspective of the use of technology incorporated into collaborative teaching. Based on this bias, 65 documents referring to the three platforms were identified, in the first instance. Of this amount, twelve searches are available on the Capes Periodicals Portal platform, three on the ERIC database and another fifty on the *Scopus platform*.

TDICs in the educational context aimed at PEE students stands out, as well as the lack of basis in collaborative teaching practices.

Admitted after this screening, these studies proceeded to the next stage of data extraction (v). For the organization and systematization of the collected material, they were tabulated according to year of publication, surname of the author(s), title of the article and brief

description of the relationships established between collaborative teaching and the technology present in the document.

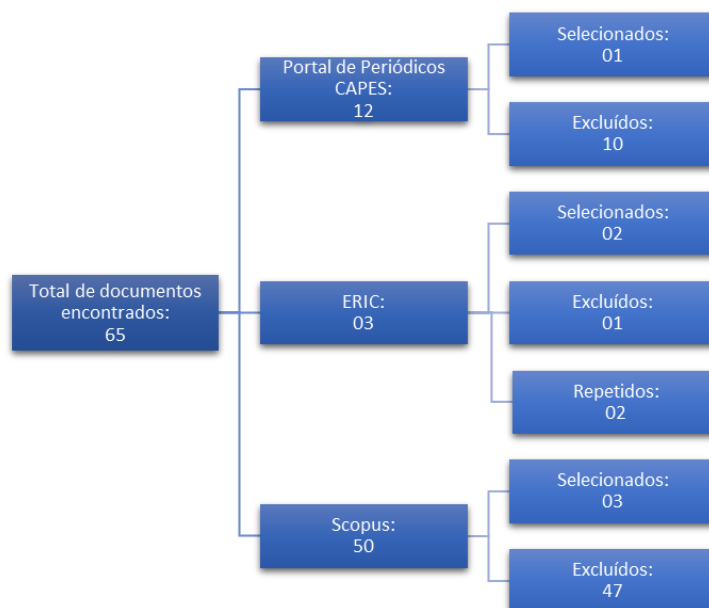
The last stage, data synthesis (vi), aims to analyze and group the collected material to answer the research question and the established objectives, based on a combination of qualitative and/or quantitative analysis of the results of the selected and tabulated studies. At this stage, it is essential that it is carried out with methodological rigor and transparency, to ensure the validity and reliability of the results of the systematic review (Galvão; Sawada; Trevizan, 2004).

After a thorough analysis carried out from the complete reading of the documents, only six sources were selected to compose the theoretical basis of this study. This selection was based on strict criteria, and it was essential that the documents addressed the use of Digital Information and Communication Technologies in the educational context, more specifically, in teaching aimed at PEE students. Furthermore, it was essential that such documents supported practices based on collaborative teaching, thus providing a comprehensive and inclusive approach to the education of these students.

The six documents selected for this research are exemplary in approaching the use of Digital Information and Communication Technologies in teaching PEE students, through practices based on collaborative teaching. Each of these resources offers a significant contribution to the understanding and improvement of this inclusive and technologically integrated educational context, allowing the analysis of adaptations and innovations occurring in the educational scenario in the face of the challenges presented by the COVID-19 pandemic.

To ensure that this entire process was followed coherently, without skipping steps, a PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) to ensure that all relevant aspects have been considered and reported appropriately (Figure 1).

Figure 1 – Prism referring to the selection of documents found.



Source: Prepared by the authors.

Results and discussion

When conducting the systematic review, although the exploration of the three database platforms resulted in 65 documents, 59 were excluded. Although they addressed relevant subjects, most of them dealt with themes close to our research purpose, however in a segmented or individualized way, without there being a relationship between collaborative teaching and technology concomitantly.

Among these discarded materials, comprehensive studies from different regions of the world stand out. Notable examples include interviews with Slovenian teachers about collaborative teaching, analysis of teaching the Qur'an to special education audiences, literature reviews on collaborative teaching and/or instruction aimed at this specific audience, as well as investigations into different teaching systems adopted by teachers in the mandatory regular education network. Although they were not incorporated into the main analysis because they do not deal with technology, the breadth and diversity of these discarded documents highlight the richness of perspectives and approaches that exist in this field, contributing to the contextualization and more comprehensive understanding of the reviewed literature.

The use of technologies in collaborative teaching

Gökbulut and Güneyli (2019) compared the effectiveness of reading texts presented through electronic books in a computer environment and regular (printed) texts in developing reading comprehension and vocabulary acquisition skills of PEE students in inclusive education environments, for this the use of the technological resource was made in partnership with the special education teacher and the regular classroom teacher, electronic texts and, in addition, electronic texts were considered more effective in improving reading comprehension skills than printed texts. Collaborative work contributed to verifying the resources used to improve students' skills.

Robbins *et al.* (2019) presented the virtual reality simulation resource on higher education students in the special education course to verify the learning effect on co-teaching and co-planning with PEE students. It was discovered that learning through simulation contributed positively to the undergraduates' learning about the proposed themes, thus contributing to their future pedagogical practices.

Following the same principles of training teachers through technology so that they can work with co-teaching for PEE students, Spencer *et al.* (2019) compared real and virtual dramatization and the learning and participation of students in an initial teacher training course (degree) preparing them to work with co-teaching. Dramatization issues were worked on in which students simulated co-teaching situations. The drama worked with virtual reality, in which students were able to carry out activities, aimed at PEE students, with other teachers. In these simulations, undergraduates faced challenges that match the school reality and coexistence with other teachers and professionals, preparing them to work with co-teaching after completing the course.

Given the Hungarian teaching context, Magyar *et al.* (2020) analyze the application of ICT for PEE students in inclusive environments. However, the research presents them in a synthetic and generalist way, such as watching videos, films and audio materials, searching for e-learning materials and using development programs, without specifying which materials, software or applications are used by professionals. The priority of this investigation is focused on teachers' perceptions of school factors linked to inclusive teaching and how these elements, combined with university knowledge, influence the use of TDIC by teachers. Thus, although the article deals with the use of TDIC, it does not present a detailed list of technologies applied in the delimited context.

Barron *et al.* (2021) proposed the incorporation of technological solutions in their co-teaching classrooms, covering traditional, remote and hybrid environments aimed at students with disabilities. In traditional co-teaching environments, video conferencing platforms such as Google Meet, Zoom and Microsoft Teams facilitate live communication between co-teachers and students, allowing active participation by both. Additionally, online formative assessment tools like GoFormative, Socrative, and Kahoot offer real-time assessment capability, allowing co-teachers to adapt instruction based on results. Also noteworthy are content sharing platforms, such as Padlet, Google Jamboard and SeeSaw, which enable collaboration and sharing of learning materials, promoting collaborative activities and demonstration of learning (Barron *et al.*, 2021).

In remote and hybrid co-teaching environments, online learning platforms such as Google Meet, Zoom, and Microsoft Teams have played a key role in enabling synchronous communication between co-teachers and students, especially in remote learning situations. Additionally, online formative assessment tools maintain their importance, enabling real-time assessment even in remote or hybrid contexts. Also noteworthy are interactive whiteboard tools, such as Whiteboard.fi, Whiteboard.chat and Classkick, which facilitate real-time collaboration, allowing co-teachers and students to interact dynamically in a digital environment. Finally, resource planning and sharing platforms, such as Google Suite, OneNote, and Trello, play a key role in enabling co-teachers to plan and share teaching resources, including lesson plans, materials, and assessments. As a result, it was possible for teachers to organize classes together and check the development of students who also used technologies during learning (Barron *et al.*, 2021).

Rodrigues (2023) analyzed whether the use of new technologies can become a driving force for inclusive transformation or an obstacle to achieving educational equity. The research was based on the Internet of Things (IoEdT), which has the ability to interconnect physical and virtual objects based on information and communication technologies, that is, a wireless technology as a collaborative tool between teachers that can be used for PEE students in their teaching-learning processes. The work showed, as a result, that with the resource it is possible for teachers together to work on student independence and social inclusion, as it will work with all students in the class in a more expanded way.

The use of technology is increasingly present and its use must be included in educational processes, but it does not always happen properly. Stinghen (2016) points out several reasons that make this happen, such as, for example, the lack of financial resources in educational

institutions, the lack of training to use the material or, even, resistance to changes, since there is the need to replace traditional teaching methods to open up new educational practices.

Final remarks

The results showed that the application of TDIC in the context of collaborative teaching for PEE students represents a promising and effective practice. The selected studies exposed different methodologies and strategies for inserting technologies into the inclusive educational context, providing substantial gains in the learning process and student participation.

The simulation of virtual reality environments, the use of bibliographic resources in electronic format and the integration of technological solutions in co-teaching environments emerged as some of the strategies identified. These practices demonstrated a positive impact on the learning process of PEE students, facilitating understanding, encouraging active participation and adapting to individual needs. Additionally, the relevance of training teachers for the effective use of TDIC in the context of collaborative teaching became evident. The training and preparation of educators to integrate technologies in an appropriate and inclusive manner have established themselves as fundamental elements for the success of the approaches.

However, it is imperative to highlight that challenges remain to be overcome. Limited financial resources and resistance to the implementation of new educational practices were identified as obstacles to the effective adoption of TDIC in the context of collaborative teaching for PEE students. In view of this, it is recommended to invest in policies and continuing education programs for teachers, aiming at training and constant updating in the handling of TDIC. Furthermore, it is urgent to promote equitable access to technologies, ensuring that all students, especially PEE students, can enjoy the benefits provided by such tools.

From this perspective, the inclusion of TDIC in collaborative teaching for this group is a significant tool to promote inclusion and optimize the learning of these students and teacher training. Through appropriate training and adequate access to technologies, it becomes feasible to establish more inclusive educational environments, where all students have the opportunity to unleash their full potential. Thus, inclusive education and the effective use of TDIC in collaborative teaching are pillars for promoting equity of opportunities and the full development of each student, regardless of their particularities or abilities.

It is further suggested that future investigations transcend the analysis of the effectiveness of digital technologies in this specific context, to also explore the impact of school culture and educational policies on the implementation of these practices. Investigating how

different educational contexts, both nationally and regionally, influence the adoption and success of technology-mediated collaborative strategies is essential for a comprehensive understanding of this field. Furthermore, longitudinal analyzes that track the effect of interventions over time can provide decisive results on the sustainability and evolution of these approaches, identifying potential areas for continuous improvement.

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Acknowledgments: We would like to thank the Special Education Postgraduate Program at the Federal University of São Carlos - UFSCar.

Financing: CAPES.

Conflicts of interest: No.

Ethical approval: Not required.

Availability of data and material: The data and materials used in the work are available for access.

Author contributions: Mariana Ferraz and Andressa França carried out the research and writing of the work. Carla Ariela Rios Vilaronga contributed to guidance and review.

Processing and editing: Editora Ibero-Americana de Educação.
Review, formatting, standardization, and translation.

