EMP Educação Matemática Pesquisa
ISSN 1983-3156
A2
http://dx.doi.org/10.23925/1983-3156.2022v24i1p611-664

Pedagogical practices mediated by digital technologies in Inclusive Mathematics Education: an exploratory study

Práticas pedagógicas mediadas por tecnologias digitais na Educação Matemática Inclusiva: um estudo exploratório

Prácticas pedagógicas mediadas por tecnologías digitales en la Educación Matemática Inclusiva: un estudio exploratorio

Pratiques pédagogiques médiatisées par les technologies numériques dans l'enseignement inclusif des mathématiques : une étude exploratoire

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Abstract

Through the analysis of Brazilian scientific publications, the objective of this exploratory study is to identify what researches that consider digital technologies in Inclusive Mathematics Education point out about the pedagogical practice. As methodological procedures, we use assumptions of mapping in Fiorentini's conception. The results indicate that the insertion of technologies leads to the displacement of pedagogical practice. Thus, teaching pedagogical practices occur in a context different in the classroom and at the time of mathematical content development. On the other hand, the integration of technologies with pedagogical practices promotes shared pedagogical actions characterized by constant interaction between teachers and students. The analyzes show that these two pedagogical

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practices can happen concomitantly in the same school context, as both allow subsidies for reflection on digital inclusion and the gradual use of technologies by students assisted by Special Education.

Keywords: Inclusive Mathematics Education, digital technologies, bibliographic research.

Resumo

Mediante a análise de publicações científicas brasileiras, o objetivo deste estudo exploratório é identificar o que as pesquisas em Educação Matemática Inclusiva, que consideram tecnologias digitais, apontam sobre a prática pedagógica do professor. Como procedimentos metodológicos, utilizamos pressupostos de um mapeamento na concepção de Fiorentini. Os resultados indicam que a inserção de tecnologias conduz ao deslocamento das práticas pedagógicas, que acontecem em um contexto diferente da sala de aula comum e de forma pontual no momento do desenvolvimento do conteúdo matemático, enquanto a integração de tecnologias na prática pedagógica promove ações pedagógicas compartilhadas, caracterizadas pela interação constante entre professores e estudantes. As análises efetuadas mostram que essas duas práticas pedagógicas podem acontecer concomitantemente no mesmo contexto escolar, pois ambas possibilitam subsídios para a reflexão sobre inclusão digital e o uso gradativo das tecnologias por estudantes assistidos pela Educação Especial.

Palavras-chave: Educação Matemática Inclusiva, tecnologias digitais, pesquisa bibliográfica.

Resumen

A través del análisis de publicaciones científicas brasileñas, el objetivo de este estudio exploratorio es identificar lo que las investigaciones en Educación Matemática Inclusiva que consideran las tecnologías digitales apuntan sobre la práctica pedagógica. Como

procedimientos metodológicos, utilizamos supuestos de un mapeo en la concepción de Fiorentini. Los resultados indican que la inserción de tecnologías conduce al desplazamiento de la práctica pedagógica. Así, las prácticas pedagógicas de enseñanza se dan en un contexto diferente al aula común y de manera oportuna al momento del desarrollo de los contenidos matemáticos, mientras que la integración de las tecnologías en la práctica pedagógica promueve acciones pedagógicas compartidas, caracterizadas por la interacción constante entre docentes y estudiantes. Los análisis realizados muestran que estas dos prácticas pedagógicas pueden darse simultáneamente en un mismo contexto escolar, ya que ambas permiten subvenciones para la reflexión sobre la inclusión digital y el uso paulatino de las tecnologías por parte de los estudiantes asistidos por la Educación Especial.

Palabras clave: Educación Matemática Inclusiva, tecnologías digitales, investigación bibliográfica.

Résumé

A travers l'analyse des publications scientifiques brésiliennes, l'objectif de cette étude exploratoire est d'identifier ce que les recherches sur l'enseignement inclusif des mathématiques, qui prennent en compte les technologies numériques, soulignent sur la pratique pédagogique de l'enseignant. Comme procédures méthodologiques, nous avons utilisé les hypothèses d'une cartographie de la conception de Fiorentini. Les résultats indiquent que l'insertion des technologies conduit au déplacement des pratiques pédagogiques, qui se déroulent dans un contexte différent de la classe ordinaire et de manière ponctuelle au moment du développement du contenu mathématique, tandis que l'intégration des technologies dans la pratique pédagogique favorise les actions pédagogiques partagées, caractérisées par une interaction constante entre les enseignants et les élèves. Les analyses réalisées montrent que ces deux pratiques pédagogiques peuvent être concomitantes dans un même contexte scolaire,

car elles permettent toutes deux de subventionner la réflexion sur l'inclusion numérique et l'utilisation progressive des technologies par les élèves assistés par l'éducation spécialisée.

Mots clés : Enseignement inclusif des mathématiques, technologies numériques, recherche bibliographique.

Pedagogical practices mediated by digital technologies in Inclusive Mathematics Education: an exploratory study

The motivation and approximation of the literature arising from the discussions of the texts carried out within the groups - Study and Research Group on Deafness and Mathematics Teaching (GPSEM), linked to the University of State of Paraná (UNESPAR/Campo Mourão), Research Group on Technology, Innovation and Teaching (GTIE), linked to the Western Paraná State University (UNIOESTE) and the Study and Research Group on Didactics of Inclusive Mathematics Education (GEPeDEMI), linked to the Federal University of Campina Grande (UFCG) – instigated us to elect as an object of study the theme of Inclusive Mathematics Education mediated by Digital Technologies[4], discussed in this article.

From these discussions and taking into account the need to build subsidies to support them, we considered analyzing what has been produced by the academy on the subject. As a first approach, we established as a field of investigation Brazilian journals that published special editions focused on Inclusive Mathematics Education, conjecturing a possible awareness of their editors regarding the topic considered and the Annals of I and II ENEMI (Encontro Nacional de Educação Matemática Inclusiva – National Meeting of Inclusive Mathematics Education). The search carried out allowed the identification of five national journals that published thematic texts focused on Inclusive Mathematics Education, namely:

- Bulletin of the GEPEM, from the Federal Rural University of Rio de Janeiro (UFRRJ), which published a thematic edition, in 2020, on Inclusão e Educação Matemática [Inclusion and Mathematics Education];
- Educação Matemática em Revista (EMR), of the Brazilian Society of Mathematics Education (SBEM), which, in 2019, published a thematic edition, with two volumes, on Educação Matemática Inclusiva [Inclusive Mathematics Education];

[4] Throughout the article, we will only use the word *technologies* to refer to *digital and assistive technologies*.

- Revista de Educação Matemática (REMAT), publication by SBEM, Regional São Paulo, which, in 2018, brought the thematic edition named Educação Matemática, Inclusão e Direitos Humanos [Mathematics Education, Inclusion and Human Rights];
- Revista Perspectivas da Educação Matemática (PEM), from the Programa de Pós-Graduação em Educação Matemática of Federal University of Mato Grosso do Sul (UFMS), with a thematic edition, in 2018, on Diversidade, Diferença e Inclusão em Educação Matemática [Diversity, Difference and Inclusion in Mathematics Education];
- Revista Paranaense de Educação Matemática (RPEM), a quarterly publication linked to the Programa de Pós-Graduação em Educação Matemática (PRPGEM), of the State University of Paraná (UNESPAR), with a thematic edition, in 2016, on Educação Matemática Inclusiva [Inclusive Mathematics Education].

The emergence of these special editions and their "almost" annual periodicity (2016, 2018, 2019 and 2020)[5] are related to the creation of the Grupo de Trabalho – GT13, of the Brazilian Society of Mathematics Education (SBEM), in 2013, entitled "Diferença, Inclusão e Educação Matemática" ["Difference, Inclusion and Mathematics Education"], which brings together researchers from different Brazilian regions interested in the subject with the objective of developing a Mathematics Education "for all", since the first of these publications, by RPEM, was organized by this GT, and those of 2018, 2019 and 2020 were organized by members of GT13.

GT13 promoted the creation of a national event, the National Meeting of Inclusive Mathematics Education (ENEMI), as a space "[...] in which the particularities associated with the mathematical practices of different learners are valued, and understood, rather than being forgotten, ignored or even considered illegitimate" (Nogueira et al., 2019, p. 4).

[5] For 2021, the call for a special issue on the topic by the magazine *Com a Palavra o Professor* is now open, linked to the Grupo de Estudos e Pesquisas em Educação Matemática – GEEM of the State University of Southwestern Bahia – UESB.

As it is a scientific event of relevance to the area of Inclusive Mathematics Education, with a significant concentration of research, we chose to also investigate the work of the I and II ENEMI – Encontro Nacional de Educação Matemática Inclusiva (National Meeting of Inclusive Mathematics), with a focus on the use of Digital Technologies for the composition of the corpus.

In this context of insertion of Digital Technologies in the field of academic research, we confirm that this article presents a mapping of works involving the use of technologies, published in Brazilian journals, with special issues focused on the topic and in scientific events on Inclusive Mathematics Education, in Brazil, in the period from 2016 to 2021. From the observation of these publications and the absence of a survey on the subject, we justify the need for an exploratory study of the mapping type, of academic works developed by Brazilian researchers, in order to identify the presence of the use of Digital Technologies in Inclusive Mathematics Education. This article, then, presents a first approach to this work.

Mapping-type research seek to systematize a field of knowledge, recognizing the main investigation results. Thus, "[...] mapping has become a resource to build a frame of reference or a theoretical scheme, in an attempt to have a broad and general perspective on a given subject or theme" (Biembengut, 2008, p. 23).

Accordingly, we sought to identify in the quantity of these research, in the Brazilian context, which of these were mediated by technologies and their influences on the teacher's pedagogical practice. The focus on the use of technologies took place considering research that indicate that, in the formal education of ordinary students, the use of technologies helps in the teaching and learning processes, as they enable different alternatives to the assimilation and elaboration of new knowledge, bringing dynamism to the learning process (Santos & Boscarioli, 2018). Along with this general issue, we seek to contemplate specific objectives, such as:

(a) characterize and analyze research publications on the topic chosen;

(b) map the construction of teaching activities based on the use of Digital Technologies;

(c) identify and understand the teacher´s pedagogical practice in researches involving Inclusive Mathematics Education mediated by Digital Technologies; and

(d) outline future research problems.

As this is bibliographic research, we chose not to bring a section of theoretical foundation, which will be carried out throughout the sections that make up this article, especially during the data analysis itself.

Then, we bring the methodological path that guides the study and present the works selected. In the 'data discussion' section, we explore two categories that emerged from the characteristics of the works mapped; we end the text with the final considerations and research perspectives.

Methodological path

Among the possibilities for bibliographic research, we adopted mapping, which, according to Fiorentini et al. (2016, p. 18), is set up as "[...] as a systematic process of surveying and describing information about researches produced on a specific field of study, covering a certain space (place) and period of time".

In view of the aforementioned and with the perspective of bringing a contribution to the debate about academic productions on Research in Inclusive Mathematics Education, mediated by Digital Technologies in Mathematics classes, of scientific publications on the subject, in the period from 2016 to 2021, we mapped and analyzed works from five journals: Boletim do GEPEM, REMAT, EMR, RPEM, PEM and the Annals of I and II ENEMI (National Meeting of Inclusive Mathematics Education).

The methodological path of the mapping followed the following steps:

i) Consultation in each of the journals and the Annals of I and II ENEMI (National

Meeting of Inclusive Mathematics Education), in order to create criteria for selection of works that were in line with the theme. As they are journals and scientific events of relevance to the field of Mathematics Education, with a significant concentration of researches, we chose to investigate the complete works that brought the expressions “Digital Technologies”, “Digital Technologies of Information and Communication” and “Assistive Technologies” in their titles, abstracts and keywords;

ii) After selecting the works, they were read in full in order to capture characteristics of the use of Digital Technologies represented in the pedagogical practice of teachers who teach Mathematics, as shown in Table 1.

Table 1.

Results of the literature mapping performed (The authors, 2021)

150	• Total works surveyed
26	• Initial refinement
17	• Refinement from the reading, in full, of the works

In total, 150 works were initially identified, according to the results shown in Table 1, with 17 selected after the two refinements carried out (≅11% of the total). Such texts are classified in Tables 1 and 2, according to the instances of the journals and the event. Once these two steps were completed, we moved on to the organization of the corpus.

In the next section, we present the summary table with information taken from the works selected and analyzed. Presented in Tables 1 and 2, include the year, volume, number, authors with their title and identification code. Researches that showed similar texts were grouped into the same category.

Table 1.

Works selected in journals (The authors, 2021)

Year	Vol.	Nº	Journal	Author and title	Code
2016	5	9	RPEM	Santos, F.L., & Thiengo, E.R. *Aprendizagem matemática de um estudante com baixa visão*: uma experiência inclusiva fundamentada em Vygotsky, Leontiev e Galperin. [*Mathematical learning of a student with low vision*: an inclusive experience based on Vygotsky, Leontiev & Galperin].	A1
				Peixoto, J.L.B., & Lopes, L.S.F. *A videoaula mediando o ensino da matemática para surdos. [The video class mediating the teaching of mathematics for the deaf*].	A2
2019	24	65	EMR	Sganzerla, M.A.R., & Geller, M. *Professores do AEE na perspectiva do ensino de matemática a alunos deficientes visuais*. [*AEE teachers from the perspective of teaching mathematics to visually impaired students*].	A3
				Anjos, D.Z., & Moretti, M.T. *A dialética dos objetos ostensivos e não ostensivos na aprendizagem matemática:* consequências para o caso de uma estudante cega. [*The dialectic of ostensive and non-ostensive objects in mathematical learning*: consequences for the case of a blind student].	A4
				Moreira, P.R., Costa, E.A.S., & Amaral, C.T.D. *Tecnologia assistiva no ensino da matemática para alunos com transtorno do espectro autista. [Assistive technology in teaching mathematics for students with autism spectrum disorder]*.	A5

Table 2.

Works selected in the Annals of I and II ENEMI (National Meeting of Inclusive Mathematics Education) (The authors, 2021)

Year	Author and title	Code
2019	Russo, A.M., & Abar, C.A.A.P. *A Plataforma Khan Academy para o ensino e aprendizagem da matemática por alunos com TDAH. [The Khan Academy Platform for teaching and learning math by ADHD students]*.	A6
	Luna, J.M.O., & Esquincalha, A. Tecnologia assistiva para o ensino do campo multiplicativo para autistas. [*Assistive technology for teaching the multiplicative field for autistic people*].	A7
	Mercado, K.V., & Baraldi, I. Análise do registro das atividades matemáticas para estudantes cegos: da tinta ao braile. [*Analysis of the register of mathematical activities for blind students: from ink to Braille*].	A8
	Faustino, T.A.S.A. *Uma experiência com o GeoGebra utilizando dispositivos móveis envolvendo alunos do 8º ano em condições especiais. [An experience with GeoGebra using mobile devices involving 8th grade students under special conditions]*.	A9
	Silva, M.A., & Segadas-Vianna, C.S. *O uso de tecnologias assistivas no ensino de matemática para alunos com deficiência visual no ensino superior. [The use of assistive technologies in mathematics teaching for students with visual impairments in higher education]*.	A10
	Anjos, D.Z., & Moretti, M.T. *Uma estudante cega e a aprendizagem em matemática*: apontamentos semiocognitivos no acesso aos objetos de saber. [*A blind student and learning mathematics*: semio-cognitive notes in accessing knowledge objects].	A11
2020	Bernado, F.G., Barbosa, P.M., Oliveira, E.D., & Garcez, W.R. *O uso potencial do Software Braille Fácil para o ensino de matemática para alunos com deficiência visual. [The potential use of Braille Fácil Software for teaching math to visually impaired students]*.	A12

	Anjos, D.Z., & Moretti, M.T. *A escrita unidirecional em Braille*: os escritos simbólicos e a aprendizagem algébrica de estudantes cegos. [*Unidirectional writing in Braille*: symbolic writing and algebraic learning by blind students].	A13
	Souza, C.G., & Bandeira, S.M.C. *Função exponencial no estudo da mitose:* uma abordagem de aprendizagem inclusiva com o uso de recursos didáticos adaptados/Tecnologia Assistiva. [*Exponential function in the study of mitosis*: an inclusive learning approach using adapted teaching resources/Assistive Technology].	A14
	Carvalho, L.S., & Mendes, R.M. *O software Elan e a Análise de Conteúdo*: possibilidades para a análise de dados em pesquisas na área da educação de surdos e surdas. [*Elan software and Content Analysis*: possibilities for data analysis in researches in the field of deaf people education].	A15
	Mercado, K.P.V., & Baraldi, I.M. *O que acontece quando passamos uma atividade matemática da tinta ao braile? [What happens when we switch a math activity from ink to Braille?]*	A16
	Silva, M.A., & Segadas-Vianna, C.C. *O uso de recursos de tecnologia assistiva para a compreensão de gráficos de funções reais na disciplina de cálculo de uma variável I para alunos com deficiência visual no ensino superior. [The use of assistive technology resources to understand charts of real functions in the calculus of a variable I discipline for visually impaired students in higher education].*	A17

Next, we discuss the results of the studies in each category, which emerged from the full readings of the works selected, and we conclude with reflections on the *corpus* as a whole.

Discussion of results

In this section, we present two categories: works that indicate the insertion of technologies in teacher's pedagogical practice and works that indicate the integration of technologies in teacher's pedagogical practice, addressed from excerpts represented in the articles analyzed, which show the insertion or integration of technologies in pedagogical practice, with each work being framed in only one category based on the main message.

Works that indicate the insertion of technologies in the teacher's pedagogical practice

We assume the expression insertion, according to the understanding proposed by Bittar (2010), as being the superficial use or as an appendix of their pedagogical practice, that is, technologies that are disconnected from their practice, such as, for example: referring students to the computer lab to teach a certain class on specific mathematical content marks that such use is isolated from the rest of the teaching process (Neves & Bittar, 2015).

Thirteen works are part of this first category (A1, A4, A5, A6, A7, A8, A9, A11, A12, A13, A14, A15, A16), which somehow express, through the texts, the insertion of the use of technologies in the teacher's pedagogical practice, as exemplified below:

> We present the content of determinant matrices and explain that we would use a different format than that applied at school, using the computer as a tool, evaluating their access to content and the acquisition of their knowledge (Santos & Thiengo, 2016, p. 115).
> In the case of this work, we discuss the focus on the difficulties perceived in the survey carried out in extra-class meetings with a blind student, in the context of teaching and learning mathematics that deals with objects of an ideal nature, objects that can only be accessed through representations (Anjos & Moretti, 2019, p. 266).
> This article aims at analyzing two educational software – "Perceber" and "Somar" – in their contributions to the teaching of Mathematics to children with autism spectrum disorder. This exploratory research included a bibliographic survey and a semi-structured interview – carried out with professionals who work directly in the school inclusion of students with this commitment (Moreira, Costa & Amaral, 2019, p. 306).
> The research aimed at studying actions that could contribute to the learning of mathematical content by students diagnosed with ADHD, as well as to contribute with fellow teachers in the search for alternatives that can help these students to overcome the obstacles encountered (Russo & Abar, 2019, p. 2).

As we can see in these four works, the other articles, belonging to this category, show that the use of technologies in the teacher's pedagogical practice occurred momentarily, in a space other than the regular classroom, that is, there was a shift from practice to the development of content, such activities/strategies functioning as extra-class activities or in teaching contexts other than the regular classroom. Based on these eight investigations, we can infer that such drift resulted in a pedagogical practice with characteristics in which the teacher controls the pedagogical actions between the individuals, when using the different types of technologies.

Anjos & Moretti (2019; 2020) bring the results of a study that aimed at discussing the relationship between ostensive and non-ostensive objects in learning and investigation with the mathematics teaching material in Braille, from a blind student in the 3rd year of High school. To that end, it had as theoretical contributions Duval's Theory of Semiotic Representation Records (1995; 1996; 2004). For data collection and analysis, activities were proposed in a

didactic sequence in extra-class meetings, during the years of 2015 and 2016, with a blind student, which took place on the premises of the library of the Federal University of Santa Catarina (UFSC).

Therefore, in addition to noting the difficulty in understanding fundamental aspects of learning geometry, the authors highlighted that the limitations imposed by writing in Braille, of some semiotic productions of ostensible objects and the perceptual tactile apprehension of drawings that must be reconfigured in geometric figures, are some of the indications that we need to pay attention to during Mathematics learning for blind students.

The study by Faustino (2019) brings results of an investigation that sought to research inclusive scenarios for mathematics learning involving the GeoGebra software, installed on mobile devices, for the study of geometric concepts with 8th grade students of Elementary School II, at a school from Belo Horizonte; A student with a report of Hyperactivity Disorder and Attention Deficit (ADHD) was enrolled in this class. This research was based on Cenário Inclusivo para Aprendizagem Matemática na perspectiva de Fernandes e Healy (2007, p. 159) [Inclusive Scenario for Learning Mathematics from the perspective of Fenandes & Healy (2007, p. 159)], as being "[...] an instructional space constituted by tasks and tools (semiotic and/or technological materials) intentionally chosen and made available, in order to stimulate interactions between the different actors who take part in the scene".

Faustino concludes favoring the understanding of the geometric concept, starting with a more intuitive process, followed by construction by handling in which the software enables a more dynamic and motivating teaching and learning process, due to the visualization window available in the software. Therefore, what can be seen in this research is the development of student autonomy in the use of GeoGebra, downloaded on their cell phones in Mathematics classes, for the development of a circumference, since it is based on their previous knowledge and from them they make their decisions, favoring the cooperation and autonomy of the

students in the class, because, "[...] by proposing an activity mediated by technology linked to work in pairs, we identified that even the students who had difficulties in the aforementioned curriculum, managed to carry out what was proposed" (Faustino, 2019, p. 9).

Another proposed application was the use of Braille Fácil software in the training of teachers who teach Mathematics to students with visual impairments (Bernado et al., 2020). The results showed that the transcription/adaptation of tables and charts, using Braille Fácil, has materialized in the production of content accessible to students with visual impairment, in the adaptation of textbooks, educational books and handouts, thus allowing students to understand the importance of carefully reading the title and identifying the axes and information contained in these representations. In this regard, they highlighted the need for educational networks to offer conditions so that school professionals can qualify to better serve students with disabilities, that is, to produce texts and teaching materials accessible to students with disabilities.

In the study by Carvalho & Mendes (2020), the authors sought, from a view of Van de Walle's (2009) ideas, to investigate the process of construction of the Decimal Numbering System (SND) by Deaf students mediated by the Brazilian Sign Language (Libras) and by visuality. Thus, the preliminary results indicated that the video recordings, the field diary and the records of students during teacher's pedagogical practice at the "Centro de Atendimento Educacional Especializado", analyzed using the software Elan 5.8[6] and Apowersoft[7] Video Converter Studio, allowed understanding with more clarity the events during the Decimal Numbering System (SND) construction process, mainly capturing emotions and the construction/mobilization of mathematical concepts by the deaf students.

In general, researches have shown that the use of different types of technologies for the

[6] Elan is annotation software for audio and video recordings. https://archive.mpi.nl/tla/elan
[7] An audio/video converter software. https://www.apowersoft.com.br/conversor-de-video

development of mathematical content, such as computers (Santos & Thiengo, 2016), Braille (Anjos & Moretti, 2019, 2020; Mercado & Baraldi, 2019, 2020) , educational software – "Perceber" and "Somar (Moreira, Costa, & Amaral, 2019), Khan Academy platform (Russo & Abar, 2019), TEACCH environment (Luna & Esquincalha, 2019); GeoGebra software (Faustino, 2019; Souza & Bandeira, 2020), Braille Fácil software (Bernado et al., 2020), Elan software (Carvalho & Mendes, 2020), contribute to the teaching of Mathematics for students with disabilities. Thus, the use of the different types of digital assistive technologies represented in the works configures programmed and evaluated pedagogical actions to ensure greater independence and autonomy for people with disabilities during the drift from mathematical activities (Sganzerla & Geller, 2019).

The insertion of technologies in the pedagogical practice of teachers who teach mathematics, represented in the works analyzed, indicates that teachers adapt according to the purpose of the class to meet the needs of students with disabilities, so that they can be touched, felt or heard in order to sharpen the other senses, for example, perception, handling and dynamism in potentially inclusive activities. We can translate this insertion as a concern to provide education to everyone. This shows that such care was crucial for teachers to decide how to make use of the insertion of technologies in teacher's pedagogical practice, so that their pedagogical actions would result in a drift from pedagogical practice to develop content, in order to address such concerns in the inclusive environment.

Works that indicate the integration of technologies in teacher's pedagogical practice

In this category, we are inspired by the concept of integration, as presented in the literature by Bittar (2010), which consists of making use of technologies during the different moments of the teaching process of the teacher´s pedagogical practice, that is, such technologies are interconnected in the teaching processes content or mathematical concept.

Four researches (A2, A3, A10, A17) grouped here showed evidence of the integration of technologies in the teacher's pedagogical practice, as they used different activities and methodologies in the development of mathematical content and/or concepts.

Peixoto & Lopes (2016) presented a proposal for using the video class in Brazilian Sign Language (Libras) to teach Mathematics to the deaf, with a focus on the content of division. To that end, they used micro genetics analysis associated with videography (Meira, 1994) to identify schemes of deaf youth associated with the meanings of division. The results showed students' actions in three dimensions: in gestures, in Brazilian Sign Language (Libras) and in written productions. In addition, the schemes were based on additive reasoning, regardless of the category of problem presented, whether that of isomorphism of measures (equitable sharing or quota), or of multiplicative and combinatorial comparison.

The investigation developed by Sganzerla & Geller (2019) aimed at understanding how the pedagogical practices are constituted, in relation to Assistive Technologies (AT), of teachers who teach Mathematics in Elementary Education in inclusive schools, both in the regular classroom and in the Atendimento Educacional Especializado (AEE), for students with visual impairment. The results of the observations and interviews with the individuals participating in the research showed that the teachers used different technologies in the regular classroom and in the AEE, such as, for example: recycled materials, Golden Material, Braille typewriter and enlarged calculator. In summary, the different methodological strategies adopted by the teachers during the class reinforce that the planned use of technologies can help in the teaching of Mathematics.

Silva & Segadas-Viana (2019; 2020) studied the learning of content from the subject Calculus I, by a student with visual impairment, with emphasis on the use of Dosvox, Braille

Fácil and Sonoramat[8] technologies. In addition to the observation carried out during the course of the subject, the researchers interviewed the student in order to map the difficulties and successful pedagogical practices in the teaching and learning process of the content chosen, both for sighted and visually impaired students. The authors highlighted the possible contributions to the field of Special Education from the perspective of Inclusive Education, brought by the narratives of teachers and students involved in the process of teaching and learning the content of the subject Calculus I using technologies. To illustrate the integration of technologies in the teacher´s pedagogical practice, in the four works grouped in this category, we exemplify below with excerpts taken from the works.

> To meet the specific needs of this group of students, we are committed to technological resources to promote access to mathematical knowledge. Particularly, in this experience report, we present a proposal for the use of video classes in the teaching of mathematics for the deaf [...] (Peixoto & Lopes, 2016, p. 236).
> [...] to present the perceptions collected during the pedagogical practices of three teachers who teach Mathematics in the AEE to students with visual impairments in an inclusive school belonging to Porto Alegre/RS city. The actions of teachers, promoting sensory experiences and exchanges between peers, show that students, research participants and assisted in the AEE, are fully able to abstract mathematical concepts, as blind or low vision people are autonomous in the execution of their tasks, however, in the classroom, specifically, they need concentration, limited space and silence to hear information (Sganzerla & Geller, 2019, pp. 190-207).
> [...] investigate which assistive technologies are most suitable for the graphs comprehension of real functions in the discipline of Calculus of a variable teaching this concept to students with visual impairment, analyzing: (a) the syllabus of this concept (from the perspective of the subject Calculus I), (b) the difficulties presented by the student with visual impairment in understanding this content of the subject Calculus I in higher education, and (c) the effect of use of assistive technologies for learning this content (Silva & Segadas-Vianna, 2020, p. 8).

Researches by Peixoto & Lopes (2016), Sganzerla & Geller (2019) and Silva & Segadas-Viana (2019; 2020) indicated that there is a debate on the themes addressed to Inclusive Mathematics Education as a practice and line of investigation in Brazil, with researches developed considering different levels of education, from Elementary Education to

[8] The assistive digital technological resources *Dosvox*, Braille Fácil and *Sonoramat* are programs developed at the Electronic Computing Center of the Federal University of Rio de Janeiro (UFRJ).

Higher Education. In addition, they converge at the same point of intersection, that is, the integration of the digital and assistive technological resource in teacher education (A3), which, in turn, allows us to understand the learning of Mathematics teachers and the different forms of appropriation of digital technologies in their practice and in the student's mathematical learning (A9), when it enables inclusive scenarios for mathematical learning. Therefore, these researches indicated that the use of technologies provided students with a deepening of the mathematical content or concept, as well as made it possible, throughout the teaching process, to carry out experiments to solve the activities proposed, that is, an integration of the temporality of technologies in the learning process of teachers and students, so these technologies can help in learning and social and educational inclusion.

We also identified that the proper use of technologies, in the teaching of mathematical content or concept in the teacher's pedagogical practice, occurred during different moments of the teaching process, enabling greater independence and autonomy for people with disabilities (Sganzerla & Geller, 2019). In this sense, students feel part of society through the use of assistive digital technologies, contributing to the construction of knowledge, especially in the teaching of Mathematics, "[...] because students with visual impairments need technologies that can support their peculiarities, in this case the absence of the sense of sight" (Sganzerla & Geller, 2019, p. 207).

We infer, from the data presented, that the use of technologies represented in the four studies evidenced pedagogical actions shared between the individuals involved in this pedagogical practice. Such sharing occurred in actions carried out between teachers and between teachers and students, when they shared the pace of pedagogical practice to develop certain school content, mediated by the use of technological resources, respecting the student's learning time. These actions of teachers can be understood as changes in pedagogical practices, given the contribution to the learning process of students with

disabilities.

Table 3 summarizes the discussions presented throughout this section, which enabled us to identify, in researches on Inclusive Mathematics Education mediated by technologies, two pedagogical practices. In the first subsection – works that indicate the insertion of technologies in the teacher's pedagogical practice –, we infer that there was a shift from pedagogical practice to develop the content, that is, the practice is developed in the Computer Laboratory or in another extra-school space to be a classroom on an ad hoc basis.

The research allowed us to understand that these works applied ad hoc uses of technologies in the teacher's pedagogical practice and, thus, instilling a momentary interaction between teachers and students. We thus identified that the use of technologies, according to the works in question, create a non-school environment for the construction of knowledge, as the technologies were used at a certain point in the teaching process and in an extra-class place, which resulted in a departure from pedagogical practice.

Whereas in the second subsection – works that indicate the integration of technologies in the teacher's pedagogical practice –, the four works allowed us to infer that shared pedagogical actions occurred, that is, the communication established in shared pedagogical practice was characterized by a constant interaction between teachers and students. Due to the identification itself, we found that this category encompasses researches in which the integration of technologies was present throughout the process of solving some activity related to a certain mathematical content, characterizing practices that tend to provide all students with a deepening of the object of study, as well as the production of new knowledge within the context.

Table 3.

Summary of the categories discussed (The authors, 2021)

Categories	Articles	Relations between individuals
Works that indicate insertion	A1, A4, A5, A6, A7, A8, A9, A11, A12, A13, A14, A15, A16	Drift from pedagogical practice to develop content
Works that indicate integration	A2, A3, A10, A17	Shared Pedagogical Actions

In short, the two categories addressed here reinforced, even more, that the use of technologies in/for the teacher's pedagogical practice, represented in the 17 works, reinforces the relationships between the individuals participating in inclusive education and the way in which technologies were used in the subject Mathematics, thus contributing to the social inclusion of all students. Morais & Fagundes (2011) and Bersch (2017) highlight the relevance of the search for adapting the school to the specificities of the 21st century.

This means, among other aspects, an education focused on accessibility contexts, with the objective of serving all individuals involved in shared pedagogical practice – represented by the integration of technologies during pedagogical practice or the drift from this practice – when technologies function as auxiliary to pedagogical practice, that is, they are used occasionally in practice.

However, both pedagogical practices can contribute to the process of inclusion, emancipation, accessibility and autonomy of all students, as the gradual use of technologies as mediators, both in the teaching and learning process, respects the learning time from specific educational needs.

Thus, we infer that the technologies discussed here can provide the classroom with a more attractive and dynamic space, providing students with a reflection between the content worked and its experience (Romeiro, Garcia & Romão, 2021). We also emphasize that these two pedagogical practices can take place simultaneously in the same school context, and all of

them, in a way, are relevant for thinking about digital inclusion and, increasingly, the gradual use of technologies by students assisted by Special Education. However, we believe that the insertion and/or integration processes need to presuppose, in addition to technological fluency, the preparation of potentially inclusive activities that permeate an intentional planning necessary for the development of pedagogical practices that involve the appropriation of technologies, as well as requiring thinking about critical appropriation of these technologies and collaborative work among teachers (Marcon et al., 2021). For Veiga (2008, p. 267), "[...] teaching planning is the result of an integrative process between the educational institution and the social context, carried out collaboratively by teachers and their students".

We observed that all the proposed activities provided opportunities, to a greater or lesser extent, interactive and creative processes, especially with regard to technological fluency to ensure the need for equity of access, as well as providing opportunities for the empowerment of students through technologies and recognizing their communicational potential, educational and political (Marcon, 2015). Related to this, Teixeira (2010, p. 33) argues that in pedagogical practices mediated by technologies we need to endorse the search for digital fluency, understood as "[...] a dynamic and provisional process that renews and improves in action and in the interaction of nodes on the network of meanings and their interconnections". This happens when we realize that schools, in their practices, go beyond the simplistic conception of access to technologies and their instrumentalization (Alonso et al., 2014).

Furthermore, these categories also indicated the use of different methodological and theoretical approaches to implement inclusive scenarios with a focus on mathematical learning, so that technologies can support potentially inclusive strategies favoring the development of skills and competences linked to human training, intellectual and social skills of all students.

In summary, we identified 17 studies aimed at proposing changes in relation to the conventional classroom, seeking to insert or integrate technologies into the teacher's

pedagogical practice with inclusive characteristics. The pedagogical practices developed demonstrated dialogic interactions between teachers and students, articulation between the proposed pedagogical practice and educational planning at the level of education.

Final considerations

The present study aimed to identifying, evidencing and understanding how Digital Technologies in researches involve Inclusive Mathematics Education, in works that were published in national journals. In the preliminary analysis carried out, based on scientific publications in the following academic vehicles Boletim do GEPEM, REMAT, EMR, RPEM, PEM, I Encontro Nacional de Educação Matemática Inclusiva and II Encontro Nacional de Educação, ENEMI (National Meeting of Inclusive Mathematics Education), we evidenced few works using technologies that instigated studies on pedagogical practice with students supported by Education Special, in a common room and in the Atendimento Educacional Especializado (AEE). The contexts/individuals of the investigations carried out indicated that the studied theme permeates and branches from regular classrooms to teacher training in an inclusive perspective. The works analyzed were categorized as follows: (1) Works that indicated the insertion of technologies in the teacher's pedagogical practice; and (2) Works that indicated the integration of technologies in the teacher's pedagogical practice.

Although the discussions present in the 17 works have the same theme, that is, how technologies are represented in the pedagogical practices of teachers who teach Mathematics, it does not converge to the same purpose. The discussions in (1) are related to the insertion of technologies in the teacher's pedagogical practice, in a Mathematics activity, by the teacher. Therefore, we understand that the insertion of technologies leads to the drift from pedagogical practice, that is, teaching pedagogical practices take place in a different context from the common classroom and in a timely manner, in which students have appropriated the technologies in educational situations that provide and explore features at the time of

development of mathematical content.

Whereas the discussions in (2) address the integrations that the teacher performs when integrating technologies into pedagogical practice, which requires planning actions and teaching strategies for the integration of mathematical activities/tasks in the school context in which the student with disabilities is inserted.

The analyzed researches show that the integration of technologies in the pedagogical practice took place through shared discussions, which guided the planning of actions by teachers and students with disabilities when developing mathematical activities. We assume, in this case, that students could appropriate the technologies in a continuous perspective, as they have been used as research instruments throughout the educational process, prevailing instructional activities such as: typing texts, reading, handling, among others.

The results of this first approach to mapping can contribute to future studies involving technologies in the fields of Teaching and Education. Due to the scenario detected by this study, there are many possibilities to be investigated and many pedagogical practices to be proposed and developed, whose results will be published in journals and in Annals of national and international events. T

herefore, we intend to enter the academic research of other journals in the field of Mathematics Education, and national and international events that discuss the subject under study, in order to complete this mapping, with the awareness that studies of this type will never be completed, requiring of periodic complements.

Thanks

We thank the Dean of Graduate Studies, Research and Technological Innovation (PROPIT), of the Federal University of the South and Southeast of Pará (UNIFESSPA), for the Support to Qualified Publication (PAPQ).

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