

**A TRAINING PROPOSAL MEDIATED BY DIGITAL TECHNOLOGIES IN NEUROSCIENCES AND INCLUSIVE EDUCATION: DEVELOPMENTS FOR TEACHER PROFESSIONAL DEVELOPMENT**

**UMA PROPOSTA FORMATIVA MEDIADA POR TECNOLOGIAS DIGITAIS EM NEUROCIÊNCIAS E EDUCAÇÃO INCLUSIVA: DESDOBRAMENTOS PARA O DESENVOLVIMENTO PROFISSIONAL DOCENTE**

**UNA PROPUESTA DE FORMACIÓN MEDIADA POR TECNOLOGÍAS DIGITALES EN NEUROCIENCIAS Y EDUCACIÓN INCLUSIVA: DESARROLLOS PARA EL DESARROLLO PROFESIONAL DOCENTE**



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**How to reference this paper:**

BRAGA, C. M. de S.; MULLE, R. L. D.; VERSUTI, F. M. A training proposal mediated by digital technologies in neurosciences and inclusive education: Developments for teacher professional development. **Doxa: Rev. Bras. Psico. e Educ.**, Araraquara, v. 25, n. 00, e024007, 2024. e-ISSN: 2594-8385. DOI: <https://doi.org/10.30715/doxa.v25i00.19071>



| **Submitted:** 25/02/2024  
| **Revisions required:** 04/07/2024  
| **Approved:** 09/07/2024  
| **Published:** 29/07/2024

**Editor:** Prof. Dr. Paulo Rennes Marçal Ribeiro  
**Deputy Executive Editor:** Prof. Dr. José Anderson Santos Cruz

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**ABSTRACT:** The present study aims to describe a training proposal mediated by digital technologies with a focus on the intersection of neurosciences and inclusive education. A case study was carried out through online training on neurosciences and inclusive education with teachers from the basic education network. The training was analyzed based on seven characteristics of training actions with the greatest impact on the quality of education. In relation to the items described, all proposed characteristics were covered in different proportions. Therefore, based on the data and strategies presented, the importance of training actions to promote contextualized knowledge aimed at changes in teaching practice is suggested.

**KEYWORDS:** Teacher Professional Development. Digital Technologies. Neurosciences. Inclusive education.

**RESUMO:** *O presente estudo tem como objetivo descrever uma proposta formativa mediada por tecnologias digitais com foco na interseção das neurociências e educação inclusiva. Foi realizado um estudo de caso de uma formação on-line sobre neurociências e educação inclusiva realizada com professores da rede básica de ensino. A formação foi analisada a partir de sete características de ações formativas com maior impacto na qualidade da educação. Em relação aos itens descritos, todas as características propostas foram contempladas em diferentes proporções. Dessa forma, a partir dos dados e estratégias apresentadas, sugere-se a importância de ações formativas promoverem conhecimento contextualizado que visem mudanças na prática docente.*

**PALAVRAS-CHAVE:** *Desenvolvimento Profissional Docente. Tecnologias Digitais. Neurociências. Educação Inclusiva.*

**RESUMEN:** *El presente estudio tiene como objetivo describir una propuesta de formación mediada por tecnologías digitales con enfoque en la intersección de las neurociencias y la educación inclusiva. Se realizó un estudio de caso de capacitación en línea sobre neurociencias y educación inclusiva realizada con docentes de la red de educación básica. Se analizó la formación a partir de siete características de las acciones formativas con mayor impacto en la calidad de la educación. En relación a los ítems descritos, todas las características propuestas fueron cubiertas en diferentes proporciones. Por lo tanto, a partir de los datos y estrategias presentados, se sugiere la importancia de acciones formativas para promover conocimientos contextualizados orientados a cambios en la práctica docente.*

**PALABRAS CLAVE:** *Desarrollo Profesional Docente. Tecnologías digitales. Neurociencias. Educación inclusiva.*

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## Introduction

Currently, professional training has been accompanied by changes in political, social, and cultural spheres, as well as the development and potential impacts of digital technologies (Modelski; Giraffa; Casartelli, 2019). As in other contexts, teacher professional development is also affected by such changes, making it essential to describe and analyze the possibilities of training proposals using digital tools. Additionally, understanding the knowledge and practices involved in these actions that can truly integrate with the teacher's reality is relevant for these trainings to reflect potential changes in education. In this regard, considering a training proposal on the theme of inclusion and neurosciences also necessitates reflecting on the conceptions of professional development and the characteristics of training that can generate positive impacts in the context.

## Teacher Professional Development

Teacher professional development can be understood as a continuous and ongoing process of transformation within the teaching profession, which includes aspects of initial and ongoing training that develop professional skills, as well as relevant knowledge and attitudes in the field (Imbernón, 1994).

Promoting training within the context of teacher professional development is essential due to the need for changes in established educational practices and the importance of innovations, especially related to the use of technologies (Peripolli; Bemme; Isaia, 2021). In this sense, Moriconi *et al.* (2017), through a review of studies aimed at evaluating the quality of teacher continuing education programs, identified common characteristics of programs with positive effects in the school context, including: focus on pedagogical content knowledge; active learning methods; collective participation; sustained duration; coherence.

Seeking evidence of training proposals that result in changes in teacher practices, a review of 35 international studies from the last three decades suggests the importance of addressing the following aspects (Darling-Hammond; Hylar; Gardner, 2017; Centro de Excelência e Inovações em Políticas Educacionais, 2018):

a) Focus on content: directing training proposals to encompass concepts that are specific to the school subjects that teachers teach (e.g., mathematics) or content related to didactics and learning;

b) Active learning: Although it is not clearly defined in the documents what active learning entails, it is understood to be related to the integration of teachers' own experiences and needs with the learning promoted in the training sessions. This can include activities involving practices for teachers to analyze, experiment with, and reflect on new strategies.

c) Collaboration: Including mutual support practices among teachers, whether in pairs, groups, or even between various schools, fosters better outcomes. Creating opportunities for collaboration during training allows consideration of the context and system in which the teacher operates, potentially forming collaborative communities that can positively impact that context.

d) Use of models and teaching techniques: Access to real models and practices can guide teachers in basing good practices. Classroom situation recordings, lesson plans, or case reports can be utilized.

e) Expert support: Monitoring and support from professional specialists who can share their experiences and knowledge on a specific topic can facilitate the implementation of changes in teaching practice.

f) Feedback and reflection: Besides mastering concepts, quality training should involve time for teachers to reflect on their practice. Additionally, the opportunity to make changes in their teaching actions and receive feedback on these initiatives is crucial for the consolidation of long-term positive effects.

g) Sustained duration: Alongside all the mentioned factors, the effectiveness of training proposals for teacher professional development also depends on the duration of the training. One-off and fragmented lectures, traditionally presented to teachers, do not provide opportunities for learning related to practice.

Continuing education should, therefore, aim to include in its curriculum characteristics that truly promote teacher professional development and its intersection with professional practice (Silva; Souza, 2018).

## Education and Digital Technologies

In education, the use of digital technologies has driven changes in the ways of working and has been used as a tool to enhance the teaching and learning process, although it also presents challenges in its use (Minuzi *et al.*, 2022). Additionally, the use of digital technologies in education has expanded, especially with the emergency remote teaching condition imposed by the COVID-19 pandemic, as indicated by Versuti *et al.* (2021). The authors argue in their work that digital resources, when applied in the educational context, generate the potential to achieve learning objectives through the intersection of the digital tool and the strategy for its use, with the teacher acting as a facilitator of the digital resources that mediate the teaching and learning processes.

According to Moreira and Schlemmer (2020), digital technologies, by themselves, do not change teaching and learning practices, requiring prior reflection regarding their application in educational practices as a process with specific characteristics and diverse impacts (both positive and negative). Borges (2018) argues that the integration of digital resources in the educational context allows the development of new teaching methods; however, the actions of teachers in this regard should be a focus of reflection concerning the use of these resources. It is understood that these resources can take on a dual role: both in the way teachers use digital tools and how these tools can be employed in their professional development. In this context, Boscaroli (2022) emphasizes that digital tools play a significant role in the continuing education of teachers, who are trained through the use of digital resources and can utilize these same resources in their professional activities.

Therefore, the scientific literature in the field indicates that the use of digital technologies in different educational contexts is not limited to the mechanical use of tools. It encompasses reflective and mediating aspects, considering the perspectives of the various agents involved in the teaching and learning processes. Thus, the next step is to identify and adapt the use of digital technologies according to the context of the application and the themes to be addressed.



## **Inclusive Education and Neurosciences**

In the context of education for all, school inclusion has become an increasingly practical and everyday demand for teachers. However, this does not diminish the challenge of considering diversity within such specific characteristics in a standardized teaching paradigm (Vier; Silveira, 2017). The proposal for inclusive education has been supported by Brazilian legislation (Brasil, 1988, 1996, 2011, 2015). Nevertheless, the support materials for teachers are often poorly contextualized and contain broad guidelines, making it difficult to integrate them with practical application (Rosin-Pinola; Del Prette, 2014).

It is noteworthy that, according to the National Policy on Special Education in the Perspective of Inclusive Education (Brasil, 2008), special education becomes part of the regular teaching proposal, targeting students with disabilities, global developmental disorders, and high abilities/giftedness. Additionally, it also includes students with specific functional disorders (dyslexia, dysorthographia, dysgraphia, dyscalculia, attention deficit hyperactivity disorder, among others). This article adopts the definition of the target audience for special education as described by the aforementioned 2008 policy. It highlights that the target audience for special education involves more students than those receiving specialized educational assistance, as specified by decree no. 7,611, dated November 17, 2011, which includes students with disabilities, global developmental disorders, and high abilities or giftedness (Brasil, 2011).

Inclusion involves not only the students' access to the school environment but also curriculum adjustments to ensure their participation. Curriculum adjustment can be defined as “implementing flexibilizations, adaptations, and accommodations in pedagogical practices, considering the specificities, understanding, style, and difficulties of each student” (Fonseca *et al.*, 2020, p. 37, our translation). Furthermore, organizational changes within the educational institution and continuous reevaluation of the school's role are crucial to promoting the development of students who are the target audience of special education (PAEE) (Maria, 2013). Thus, it is essential to consider the impact of various factors on the effectiveness of inclusive education, including school infrastructure, pedagogical strategies, and curriculum (Loveys, 2022; Organização das Nações Unidas para a Educação, a Ciência e a Cultura, 2019; Palaro; Santos Cruz, 2021; Vieira; Omote, 2021).

In addition to the mentioned factors, the role of the teacher in the quality of education is widely recognized. Particularly concerning the professional development of teachers, a study conducted with educators who participated in inclusive education training indicated that, after this training, the teachers were able to implement various support methods for students with

disabilities in their classrooms. These methods include cooperative learning, peer learning, ability grouping, intensive use of visual resources, and curriculum differentiation (Van Der Merwe; Fourie; Yoro, 2020).

Recognizing and addressing diversity in the classroom is a fundamental aspect of a teacher's work. Understanding different learning styles, as well as each student's unique abilities and challenges, is crucial for pedagogical planning (Walker *et al.*, 2019). Therefore, it is essential for teachers to have access to knowledge, including that from neuroscience, which helps them understand learning as a complex and diverse phenomenon (Gama; Ferracioli, 2019).

A study conducted by Chang *et al.* (2021), describes a three-week training offered to a group of teachers. The results indicate that understanding the characteristics of cognitive functioning can enable teachers to experiment with new teaching and learning strategies based on neurobiological explanations. The authors note that the outcomes varied among teachers, suggesting the need for further research. Thus, the study promotes the discussion about the role of teachers in using neuroscience knowledge not only to learn but also to effectively apply it in the classroom, thereby improving the understanding of teaching and learning processes.

Neuroscience plays a crucial role in supporting teachers in inclusive education by providing insights into brain functioning and learning processes, ultimately enhancing teaching strategies for diverse students. Studies emphasize the importance of incorporating neuroscience into teacher training to promote inclusive practices (Mayelín; Linet; Oscar, 2021; Frei-Landau; Grobged; Guberman, 2023).

Thus, professional development proposals that address inclusive education and neuroscience can broaden teachers' perspectives and actions toward students who are the target audience of special education. Describing actions focused on this theme, anchored in digital education, has the potential to reach more teachers in different locations and contexts. A survey conducted in May 2021 by Borges (2022) in Capes, Scielo, and Google Scholar journals using the descriptors "Special Education," "Neuroscience," and "Teacher Training" and selecting works from the last ten years, found only three published works. Although other indexes can be considered, the gap in this field is worth noting, given the small number of publications during the period. Thus, the aim of this article is to describe a training proposal mediated by digital technologies focused on the intersection of neuroscience and inclusive education.

## Methodology

This study was designed as a cross-sectional descriptive study (Cozby, 2003) of an integrative training proposal combining the fields of inclusive education and neuroscience. A case study research method (Yin, 2015) was employed to describe the stages and teaching-learning strategies of the course "Neuroscience and Inclusive Education."

To achieve the study's objective, the tools used in the course, as well as the curricular matrix, planned pedagogical activities, workload, and pedagogical team, were described. This information was analyzed based on the parameters outlined by Darling-Hammond, Hyler, and Gardner (2017), which include: focus on content; active learning; collaboration; use of teaching models and techniques; specialist support; feedback and reflection; and sustained duration.

The training was developed based on needs identified from the professional experience of the lead researcher over four years in the educational context. In 2020, the "Neuroscience and Inclusive Education" training began to be developed as part of a doctoral project, going through the planning and evaluation process in the field of scientific research. The training was offered in the first and second semesters of 2021 to primary education teachers, in an online format.

The course was advertised through the university system and the research laboratory's social media. Inclusion criteria included: 1) completion of a teaching degree or teaching certification; 2) working in primary education in Brazil. A total of 120 teachers enrolled in the course, and 108 started the program. Before starting the course, participants were given access to the Free and Informed Consent Form and were informed about the research project "*Neurociência e Educação Inclusiva: avaliação do efeito de um programa de formação de professores*"<sup>4</sup> approved by the Research Ethics Committee with Humans under CAAE: 40838820.2.0000.5407.

The course was structured within the Google Classroom virtual learning environment. This platform was chosen for its ability to integrate video calling, forums, forms, and activity submissions. Prior to each module, reading materials were made available. These materials included scientific articles and videos and were divided into "essential materials," necessary for participation in the session, and "support materials," which offered complementary and optional readings on the topic. Before each class, teachers completed a multiple-choice questionnaire via Google Forms, covering fundamental concepts from the essential materials. This

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<sup>4</sup> Neuroscience and Inclusive Education: Evaluation of the Effect of a Teacher Training Program.



questionnaire aimed to map participants' prior knowledge so that the instructor could emphasize concepts that generated the most questions during the session.

The online classes lasted for 2 hours each, conducted via the Google Meet platform and structured dialogically, including content presentation and teacher participation. At the end of each session, participants completed the questionnaire again to verify if they had learned the concepts and to self-assess their performance. Following the class, teachers engaged in a consolidation activity designed to involve practical situations from their daily teaching related to the discussed content, such as planning steps for adapting an activity for a student with Autism Spectrum Disorder. As a concluding activity, participants were asked to produce a critical and reflective piece on the covered content, linking it to their professional experiences and the current educational context. Considering all activities, reading assignments, and online class participation, the course amounted to a total of 40 hours.

Participants were divided into two groups, taking the course at different times, with 58 in group 1 and 50 in group 2. Separate virtual learning environments were created for each group, although they contained the same content, tools, and activities. The teachers ranged from early childhood to high school educators, with 76.85% residing in the state of São Paulo, although the sample included participants from eleven Brazilian states. Across both groups, 86 teachers completed at least 75% of the activities, indicating a high level of engagement with the program.

Regarding the participants, 5.7% worked exclusively in public education, while 25% were in the private sector. The remaining participants reported working for non-governmental organizations or in multiple networks simultaneously. In terms of previous experience with inclusive education in the classroom, the majority (79.63%) had such experience. Notably, 59.3% of these participants had previously engaged in continuing education on inclusive education (Table 1). This data highlights the importance of addressing this topic in professional development initiatives, given that slightly over 40% of teachers had prior experience with inclusive education but had not received specific training.

**Table 1 – Descriptive Statistics for Continuing Education and Previous Experience in Inclusive Education**

| Do you have or have you had any experience with inclusion in the classroom? | Have you previously participated in continuing training on inclusive education? | Frequency | Percentage |
|---|---|-----------|------------|
| No  | No  | 18        | 81,8       |
|   | Yes   | 4         | 18,2       |
|   | Total   | 22        | 100,0      |
| Yes   | No  | 35        | 40,7       |
|   | Yes   | 51        | 59,3       |
|   | Total   | 86        | 100,0      |

Source: Prepared by the authors.

## Results and Discussion

The characteristics of the conducted training will be presented, along with the technology-mediated teaching and learning strategies utilized. To analyze the results, the principles of training programs that have shown the greatest impact on changes in teaching practices will be considered. These principles include: focus on content, active learning, collaboration, use of models and teaching techniques, specialist support, feedback and reflection, and sustained duration (Darling-Hammond; Hyler; Gardner, 2017; Centro de Excelência e Inovações em Políticas Educacionais, 2018).

## Focus on Content

The content covered in the training was aimed at understanding learning from the perspective of neuroscience, with a focus on the target audience of special education (Table 1):

**Chart 1 – Curriculum Content and Learning Objectives of the Neuroscience and Inclusive Education Training, by Week**

| Week | Theme  | Learning Objective   |
|------|--|--|
| 1    | Presentation, training in using the platform and preparation for the course                                  | Use the virtual learning environment.  |
|      |  | List the steps necessary to prepare participants for each course meeting.                                |
| 2    | Basic concepts of cognitive functioning and Case Study using the International Classification of Functioning | Identify that cognitive functioning is a complex process.  |
|      |  | List the cortical lobes, as well as identify their functions and relationship with the learning process. |

|   |   |  |
|---|---|--|
|   |   | Conceptualize Functionality and analyze its application as a tool for curricular flexibility.  |
| 3 | The brain and child development: windows of development, neuroplasticity and executive functions  | Define executive functions based on the model proposed by Adele Diamond and relate it to learning.   |
|   |   | Differentiate growth, maturation and development.  |
|   |   | Identify stages of cognitive development.  |
| 4 | Neurodevelopmental Disorders and possibilities for curricular flexibility: Autism Spectrum Disorder   | Describe characteristics of cognitive functioning specific to Autism Spectrum Disorder and relate them to possibilities for curricular flexibility in the classroom context.   |
| 5 | Neurodevelopmental Disorders and possibilities for curricular flexibility: Specific Learning Disorders  | Describe characteristics of cognitive functioning specific to Specific Learning Disorders and relate them to possibilities for curricular flexibility in the classroom context.  |
| 6 | Neurodevelopmental Disorders and possibilities for curricular flexibility: Attention Deficit Hyperactivity Disorder and Developmental Coordination Disorder | Describe characteristics of cognitive functioning specific to Attention Deficit Hyperactivity Disorder and relate it to possibilities for curricular flexibility in the classroom context.   |
|   |   | Describe characteristics of cognitive functioning specific to Developmental Coordination Disorder and relate it to possibilities for curricular flexibility in the classroom context.  |
| 7 | Neurodevelopmental Disorders and possibilities for curricular flexibility: Intellectual Disability and Down Syndrome  | Know different perspectives on intelligence and describe characteristics of cognitive functioning specific to the Intellectual Disability framework, relating them to possibilities for curricular flexibility in the classroom context. |
|   |   | Describe characteristics of cognitive functioning specific to Down Syndrome and relate them to possibilities for curricular flexibility in the classroom context.  |
|   | Ending  | Synthesize the knowledge presented in the course and reflect on the intersection with teaching practice in the current context.  |

Source: Prepared by the authors.

The training program addressed knowledge related to the divisions of the central nervous system, cognitive functions, and neurodevelopmental disorders. The decision to cover diagnoses of neurodevelopmental disorders was based on the increased prevalence of these conditions in mainstream education today. Additionally, the target audience for special education was defined to include a broader range of conditions beyond Autism Spectrum Disorder, Giftedness/Talents, and other Disabilities. To broaden the teachers' understanding of the context, the concept of functionality (OMS, 2013) was also discussed.

Thus, knowledge of cognitive functioning and functionality was used to develop strategies for curricular flexibility considering the neurodevelopmental disorders presented. Given the outlined schedule, the training incorporates the characteristic of content focus, which is also understood as encompassing concepts related to didactics and learning (Darling-

Hammond; Hyler; Gardner, 2017; Centro de Excelência E Inovações em Políticas Educacionais, 2018). This focus is approached from the perspective of neuroscience. It is noteworthy, however, that the training did not include concepts from the curriculum that teachers teach students, but rather focused on content related to student learning.

### **Active Learning**

Based on the premise of active methodologies, before the weekly synchronous meetings, participants had access to the pedagogical objectives for the week and relevant materials (videos and articles) on the topic. At the beginning of each weekly synchronous meeting, participants completed an online questionnaire with multiple-choice questions related to that week's theme. The questionnaire was administered digitally, allowing the facilitator to monitor responses in real time, with the aim of assessing engagement with the previously provided materials and identifying the main questions from the group. Thus, the focus of the meeting was adjusted based on the responses obtained at that initial stage.

After the synchronous meetings, the same questions were answered again, allowing participants to assess their grasp of the concepts covered during that session and enabling the facilitator to observe any changes in the initial responses. The questionnaire responses were revisited in the subsequent meeting, where the correct answers were discussed in a collective context, and space for questions and reflections was provided before the next topic was introduced.

Furthermore, considering that the participants were primary education teachers, the aim was to relate the learned content to potential intersections with teaching practice. Weekly, teachers engaged in activities related to their classroom context. These activities involved creating pedagogical proposals or analyzing school situations that the teachers either chose to report or were provided by the facilitator, always related to that week's theme, integrating their experiences with the learning promoted in the training.

Regarding active learning, understood as the integration of teachers' own experiences and needs with the learning promoted by the training (Darling-Hammond; Hyler; Gardner, 2017; Centro de Excelência E Inovações em Políticas Educacionais, 2018), the course provided various opportunities for this interaction between the proposed content and teaching practice in the activities described above.

## Collaboration

Based on the premise of collaboration among teachers, various strategies were employed throughout the training to facilitate exchanges between participants. In the virtual learning environment, a bulletin board was used as a tool for sharing experiences, materials, and questions. To stimulate interaction among participants, the first activity of the course involved introducing oneself to the group, including their name, city of residence, and teaching role, and sharing an experience with students from the target audience of special education. The course facilitator and the two monitors actively managed the bulletin board daily, aiming to maintain a constant flow of exchange with the participants. It is noteworthy that the teachers posted numerous accounts of school inclusion on the bulletin board, both personal and professional, highlighting the importance of creating spaces for exchange and collaboration.

To create opportunities for mutual assistance, from the third week of the course onwards, weekly activities focused on teaching practice were carried out in pairs or small groups. Additionally, in the final synchronous meeting of the training, participants were divided into smaller groups via videoconference to discuss the potential impacts of the experiences and concepts presented throughout the course on their own teaching practices, culminating in a final discussion with the entire group.

At the end of the course, we empowered each teacher to take an active role in their learning. They were asked to produce a critical analysis of the current state of education and their educational practice, relating it to the concepts covered during the training. The essay could be submitted either as a written text or as a video. With the teachers' permission, all submissions were compiled into a freely accessible digital document that recorded the participants' perceptions.

It is noteworthy that the collaborative model in teaching and learning actions reflects a central aspect of active methodologies by offering learners a horizontal course format focused on individual development (Versuti *et al.*, 2021). Furthermore, fostering mutual assistance among teachers, whether in pairs or groups, has been associated with better outcomes in training programs (Darling-Hammond; Hyler; Gardner, 2017; Centro de Excelência e Inovações em Políticas Educacionais, 2018).



## Use of Teaching Models and Techniques

Regarding access to teaching models and techniques, the International Classification of Functioning (ICF) framework (OMS, 2013) was used as a strategy to organize information about students with diagnoses. Examples of how to fill out the framework were presented, along with various activities throughout the course that utilized the framework as a means to organize information and consider the potential and challenges of each student. The potential of using this tool in the school context is highlighted, as it seeks to look beyond the diagnosis, considering the intersection of environmental factors and personal characteristics.

In addition to using the ICF framework, there were no systematically presented examples of lesson plans or interventions. In the synchronous meetings, during the dialogic classes, the content covered included examples of curricular flexibility for students in the target audience of special education, but without detailing the application context of these proposals. In this regard, the training did not provide a wide range of models, as suggested as a desirable feature for training by Darling-Hammond, Hyler, and Gardner (2017) and the Center for Excellence and Innovations in Educational Policies (2018).

## Support from Specialists

The proposed training involved a team of specialists not only during discussions about the content but also in the planning of formative actions, production of materials, and monitoring of the activities conducted by the participants (Table 2):

**Chart 2** – Roles, Responsibilities, and Functions of the Professionals Responsible for the Training Program

| Paper                                     | Performance  | Assigned roles  |
|---|--|---|
| Coordinator                               | University professor who guided the project and researcher in the area of teacher learning.                  | Guide the development of the didactic matrix and selection of teaching and learning tools most appropriate to the course context. |
|   |  | Monitor the implementation of the program weekly, through meetings with the minister.   |
| Responsible researcher and course teacher | Neuropsychologist, with experience with children and adolescents in special education, and doctoral student. | Develop and implement the course's didactic matrix.   |
|   |  | Select, provide, and organize materials and activities in the virtual learning environment.                                       |
|   |  | Guide a team of monitors and collaborating researchers.   |
|   |  | Teach dialogue classes online.  |
|   |  | Correct and provide individual feedback on activities carried out by participants.  |

|                          |  |   |
|--------------------------|--|---|
|                          |  | Monitor posts from participants in the virtual learning environment, as well as monitor course email.   |
| Technical monitors       | Neuropsychologist with experience with children and adolescents in special education<br>Psychologist and master's student with research in the area of learning. | Monitor and answer questions in the teachers' virtual environment.                                      |
|                          |  | Correct and provide individual feedback on activities carried out weekly by participants.               |
| Collaborating researcher | Collaborating psychologist at the research laboratory in which the training was developed.   | Prepare and layout a digital review book with a summary of the theoretical content presented each week. |

Source: Prepared by the authors.

Considering the expertise of the professionals involved in the course, knowledge from psychology and neuroscience was utilized to support the participating teachers in relation to the content studied and in the analysis and reflection of the activities conducted. Although practical implementation actions by the teachers in their teaching activities were not monitored, the professionals responsible for the training provided constant support in carrying out activities, which involved planning actions for the classroom context. This aligns with the aspect of support from specialists (Darling-Hammond; Hyler; Gardner, 2017; Centro de Excelência e Inovações em Políticas Educacionais, 2018).

### Feedback and Reflection

Most of the weekly activities proposed to participants involved the description and planning of actions by the teachers, related to their own work contexts. Consequently, there was no single correct response; therefore, feedback for each activity was provided individually via email. For correction, the instructor conducted online training for two monitors, guiding them on the objectives of each activity and the content covered that week.

In addition to the weekly activities, the critical essay at the end of the course was also seen as an opportunity to reflect on one's own practice, relating to learning the concepts covered in the training. As previously stated, it is essential to offer training programs that include, in their curriculum, spaces for reflection, experimentation, and analysis of professional practice (Silva; Souza, 2018).

Opportunities for direct observation of the participating teachers' actions were not provided, as suggested by Darling-Hammond, Hyler, and Gardner (2017) and the Center for Excellence and Innovations in Educational Policies (2018). However, even indirectly, conditions were planned for teachers to reflect and receive feedback on their reports and action plans, requested through the weekly activities and the final essay.

## **Sustained Duration**

The online training was structured to be completed in nine weeks, with seven weeks of synchronous meetings. Two additional weeks were allocated for the completion of the final course activity (critical essay). The online synchronous meetings occurred weekly on Saturdays via Google Meet videoconferencing, each lasting two hours. Asynchronous activities were carried out in the virtual learning environment (Google Classroom), completed through online forms and documents.

The virtual learning environment was maintained for six months after the intervention, allowing direct contact with the instructor and the monitors, as well as among the teachers themselves. Given that the participants were from eleven different states, maintaining an appropriate duration for the training would have been incredibly challenging without the mediation of digital technologies, with the virtual learning environment and videoconferencing meetings proving to be effective tools in this context.

While there are reports in the literature of training programs extending beyond one year, especially those predominantly offered in the form of lectures or fragmented workshops, it is considered that the present training provided various opportunities for learning and review of the content, as well as time for reflection (Darling-Hammond; Hylar; Gardner, 2017; Centro de Excelência e Inovações em Políticas Educacionais, 2018).

## **Final considerations**

This study aimed to describe a training proposal mediated by digital technologies with a focus on the intersection of neuroscience and inclusive education. Considering the proposed objective, the training was analyzed based on seven characteristics identified as important aspects to consider in planning teacher training programs. Regarding the described items, the course incorporated all proposed characteristics through digital technologies, although the use of teaching models and techniques, as well as feedback and reflection, were addressed to a lesser extent.

The seven characteristics listed in this work support conceptions of professional development that involve training experiences throughout a career and interaction between other dimensions based on personal and professional experiences. In this sense, this study aims to analyze the described training not only in terms of the content presented to the teachers but also in its entire structure, designed to promote alignment with professional reality rather than

being merely prescriptive, and interacting with the demands of the context. Thus, based on the data and strategies presented, formative proposals should include contextualized knowledge-building actions that can lead to changes in teaching practice.

Finally, it is noteworthy that the analysis was conducted based on a single offering of the training, which is a limitation to be acknowledged. Additionally, no follow-up was conducted after six months of the training, which would have been relevant for evaluating its impacts. It is suggested that data on variables before and after the course be analyzed to assess the effect of the intervention.

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### *CRediT Author Statement*

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**Acknowledgements:** I would like to thank Ana Carolina de Lima, Ariana Acioli Xavier, Ariane Alcalá Francisco, and Raquel Messi Falcoski for their contributions to the tutoring and monitoring activities of the course described in this article.

**Funding:** This work was supported by the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES) - Funding Code 001.

**Conflicts of interest:** There are no conflicts of interest.

**Ethical approval:** The work adhered to ethical standards during the research and was approved by the Research Ethics Committee with Human Beings.

**Data and material availability:** Not applicable.

**Author's contributions:** Carolina Magro de Santana Braga contributed to the conceptualization, methodology, data management, data collection and analysis, visual presentation of data, writing, and revision of the text. Co-author Rafael Lima Dalle Mulle contributed to the writing and revision of the text, and co-author Fabiana Maris Versuti was involved in project administration, conceptualization, and methodology of the work, as well as text revision.

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**Processing and editing: Editora Ibero-Americana de Educação.**  
Proofreading, formatting, normalization and translation.

