An Assistive Computer Technology Implementation Program for Students with Cerebral Palsy

Gerusa Ferreira Lourenço
Departamento de Tareapia Ocupacional, Centro de Ciências Biológicas e da Saúde, Universidade Federal de São Carlos, Brazil
gerusa@ufscar.br | https://orcid.org/0000-0002-7550-4858

Enicéia Mendes
Departamento de Psicologia, Centro de Educação e Ciências Humanas, Universidade Federal de São Carlos, Brazil
egmendes@ufscar.br| https://orcid.org/0000-0003-3673-0681

Abstract

Assistive technology devices can help students with cerebral palsy to perform everyday tasks in school more efficiently and independently. However, the implementation of such a system is a complex process and an essential element of its successful application is the involvement of a skilled and experienced team of professionals. The aim of this study was to implement and evaluate the effects of an in-service assistive technology training program for school professionals—which was developed to facilitate the learning process of students with cerebral palsy in a special school in a city located within São Paulo State (Brazil)—using a collaborative research approach. Data were collected from open-ended response questionnaires, focus groups, videotapes, and field notes. The results indicated that such a collaborative program can effectively enable teachers, school staff members and students to use these types of assistive technology devices, and additionally, that the collaborative nature of the project was of overriding importance.

Key Words

special education; assistive technology; education professionals' preparation.

SISYPHUS

JOURNAL OF EDUCATION

VOLUME 10, ISSUE 03,

2022, PP 66-85

DOI: https://doi.org/10.25749/sis.27543

Um Programa de Implementação de Tecnologia Assistiva Computacional para Estudantes com Paralisia Cerebral

Gerusa Ferreira Lourenço
Departamento de Tareapia Ocupacional, Centro de Ciências Biológicas e da Saúde, Universidade Federal de São Carlos, Brasil
gerusa@ufscar.br | https://orcid.org/0000-0002-7550-4858

Enicéia Mendes
Departamento de Psicologia, Centro de Educação e Ciências Humanas, Universidade Federal de São Carlos, Brasil
egmendes@ufscar.br| https://orcid.org/0000-0003-3673-0681

RESUMO

Os dispositivos de tecnologia assistiva podem ajudar os alunos com paralisia cerebral a realizar tarefas cotidianas na escola de forma mais eficiente e independente. No entanto, a implementação de um sistema deste tipo é um processo complexo e um elemento essencial para o sucesso da sua aplicação é o envolvimento de uma equipe de profissionais qualificados e experientes. O objetivo deste estudo foi implementar e avaliar os efeitos de um programa de treinamento em serviço em tecnologia assistiva para profissionais da escola, desenvolvido para facilitar o processo de aprendizagem de alunos com paralisia cerebral em uma escola especial de uma cidade do interior do estado de São Paulo (Brasil)—usando uma abordagem de pesquisa colaborativa. Os dados foram coletados a partir de questionários abertos, grupos focais, gravações em vídeo e diários de campo. Os resultados indicaram que tal programa colaborativo pode efetivamente permitir que professores, funcionários da escola e alunos usem esses tipos de dispositivos de tecnologia assistiva e, além disso, que a natureza colaborativa do projeto foi de suma importância.

PALAVRAS-CHAVE

educação especial; tecnologia assistiva; formação de profissionais da educação.

SISYPHUS
JOURNAL OF EDUCATION
VOLUME 10, ISSUE 03,
2022, PP 66-85

DOI: https://doi.org/10.25749/sis.27543

Un Programa de Implementación de Tecnología Computarizada de Asistencia para Estudiantes con Parálisis Cerebral

Gerusa Ferreira Lourenço
Departamento de Tareapia Ocupacional, Centro de Ciências Biológicas e da Saúde, Universidade Federal de São Carlos, Brasil
gerusa@ufscar.br | https://orcid.org/0000-0002-7550-4858

Enicéia Mendes
Departamento de Psicologia, Centro de Educação e Ciências Humanas, Universidade Federal de São Carlos, Brasil
egmendes@ufscar.br| https://orcid.org/0000-0003-3673-0681

RESUMEN

Los dispositivos de tecnología de asistencia pueden ayudar a los estudiantes con parálisis cerebral a realizar las tareas cotidianas en la escuela de manera más eficiente e independiente. Sin embargo, la implementación de un sistema de este tipo es un proceso complejo y un elemento esencial para su aplicación exitosa es la participación de un equipo de profesionales capacitados y experimentados. El objetivo de este estudio fue implementar y evaluar los efectos de un programa de formación en tecnología de asistencia en servicio para profesionales de la escuela, que fue desarrollado para facilitar el proceso de aprendizaje de estudiantes con parálisis cerebral en una escuela especial en una ciudad ubicada en el estado de São Paulo (Brasil), utilizando un enfoque de investigación colaborativa. Los datos se recopilaron a partir de cuestionarios de respuesta abierta, grupos focales, cintas de video y notas de campo. Los resultados indicaron que un programa colaborativo de este tipo puede permitir de manera efectiva que los maestros, miembros del personal escolar y estudiantes usen este tipo de dispositivos de tecnología de asistencia y, además, que la naturaleza colaborativa del proyecto era de suma importancia.

PALABRAS-CLAVE

educación especial; tecnología de asistencia; preparación de profesionales de la educación.

SISYPHUS
JOURNAL OF EDUCATION
VOLUME 10, ISSUE 03,
2022, PP 66-85

DOI: https://doi.org/10.25749/sis.27543

An Assistive Computer Technology Implementation Program for Students with Cerebral Palsy

Gerusa Ferreira Lourenço, Enicéia Mendes[1]

INTRODUCTION

Studies in different school contexts have called attention to the problems inherent in providing education for children with severe motor dysfunction, including cerebral palsy. Movement and posture difficulties and possible sensory, cognitive, communicative changes and/or behavioral problems arising from injury in the immature central nervous system (Rosembaun et al., 2007) can compromise the participation of students with cerebral palsy in school curricular activities, especially when there is no specialized educational plan (Andrade & Mendes, 2015; Silva, Martinez, & Santos, 2012).

On this issue, the Brazilian national special education policy that is currently in effect (Brazilian Ministry of Education, 2007a) dictates that in teaching students with disabilities such as cerebral palsy, strategies should be used to offer them access to the curriculum and to optimize their development in school contexts. Among these strategies, assistive technology features are highlighted for their potential to foster functionality and autonomy in carrying out activities for people with certain limitations (Brazilian Ministry of Education, 2007b, 2009). The Brazilian Law for the Inclusion of Persons with Disabilities defines assistive technology widely as an area of knowledge, involving products, devices, methodologies and practices, with a view to promoting functionality in the activities and participation of people with disabilities (Brazil, 2015). Specifically, considering their features, assistive technologies can be categorized as low or high-tech (low-tech don't usually make use of electricity, e.g., modified pencils and manipulative aids for daily activities; high-tech use conventions normally related to computer systems) as well as according to their different characteristics and purposes (e.g., activities of daily living, communication, mobility etc.) (Cook & Polgar, 2015).

The potential for using such devices with disabled students on a daily basis has motivated increased research and practical application development in Brazil. The Brazilian Ministry of Education encourages the use of assistive devices by investing in equipment distribution and training of special education teachers in Specialized Educational Services, more specifically, the Multifunction Resource Rooms. However, specifically in relation to the provision of assistive devices, international literature shows that incorporating assistive technologies into school systems is a complex process; it involves personal variables, equipment, the task to be performed, and the environment (Cook & Polgar, 2015).

Thus, although assistive technologies can play an important role in the education of many students with special needs, one must consider the importance of a careful prescription of devices and the need to monitor their implementation, which, in short, requires a team of trained professionals. In order to guarantee that technological devices

[1] Departamento de Psicologia, Centro de Educação e Ciências Humanas, Universidade Federal de são Carlos. Rodovia Washingon Luis Km 232, Monjolinho. CEP 13565-905, São Carlos, SP, Brasil.

are properly implemented, professionals must have specialized knowledge and skills to make decisions about the selection, use and evaluation of such materials (Abu-Alghayth, 2022; Chukwuemeka & Samaila, 2020; Lahm & Sizemore, 2002; Reed & Bowser, 2012; Watson, Ito, Smith, & Andersen, 2010).

In Brazil, although the application of assistive devices in special education contexts has been encouraged, there is an evident gap in the training and human resource building necessary for the implementation of assistive technology (Mendes & Lourenço, 2012). To Manzini (2009), the process of making greater use of assistive technology devices in special education should, at a minimum, include training faculty, both in special and regular education contexts. The author discusses the need for teacher training in the use of this technology in everyday school life with disabled students. Finally, he raises the possibility of continuing education specifically for these purposes, preferably with direct supervision of teachers during the process.

More specifically regarding high-tech assistive devices, Kleina (2008) proposed a continuing education program for teachers exclusively, in a specialized school in Curitiba/PR/Brazil. The program would use informatics classes to improve teachers' use of devices and educational information for disabled students. The author concluded that the experience was effective, but found it necessary to rethink teaching practices and possibilities for the use of computers in special education.

Imamura (2008) stated, after conducting a survey on continuous training of teachers to use computers in their teaching practice, that it is essential to create teacher sharing experience opportunities, apart from just demonstrating technological possibilities. These findings extend to computer-related assistive technology devices.

In order to answer the demand for implementation of these devices in the country, a research group was established in 2005; their research agenda aimed to expand the use of high-tech assistive devices in special education, in a city within São Paulo State. Over five years, studies were conducted in regular classrooms, resource rooms, multifunction resource rooms, and special schools, utilizing collaborative partnerships with a network of educators who were seeking effective means of equipment use by students with cerebral palsy in order to increase their access to the regular curriculum. The results indicated potential benefits of using such devices use within effective educational plans, but the studies relied heavily on providing high-quality human infrastructure and school materials, including teacher education (Mendes & Lourenço, 2012).

Due to the complexity of the training processes for the implementation of computerized assistive technology devices evidenced by the aforementioned literature, one suggestion endorsed by many studies was to build more intense collaborations among school professionals (teachers, special education teachers, physical educators) and other professionals (physiotherapists, occupational therapists, psychologists and speech therapists), in order to share knowledge and assess all the variables involved in adopting assistive technologies (Calheiros, Mendes, & Lourenço, 2017; Chambers, Jones, Reese, & Wilcox, 2022; Copley & Ziviani, 2004; Fernández-Batanero et al., 2022).

The importance of teams working in the interest of educating children with cerebral palsy at school was the target of several studies (Bausch, Ault, Evmenova, & Behrmann, 2008; Campbell, Milbourne, Dugan, & Wilcox, 2006; Morrison, 2007), which indicated that knowledge-sharing between all professionals increases the capacity of school teams to improve student development and implement assistive devices in the school environment. However, there remains the need for exploration of the development and application of high-tech assistive technology features in the education of pupils with cerebral palsy in the country. In this sense, the question that arises is how to promote the training of professionals in the implementation of high-tech assistive features, within a collaborative practice.

This report presents a study that sought to assess the effects of a proposed in-service training program on the implementation of high-tech assistive technology devices by teachers and professionals involved in the education of students with cerebral palsy.

METHODS

The study utilized a primarily qualitative approach involving a variant of action research, which was already being used in our research group, in investigations of the model of Collaborative Consulting as a service provision in school environments (see Sagor, 1992, and Mendes, Marques, & Lourenço, 2012 for detailed methods).

SITE CHARACTERIZATION

Location

The study was conducted in one of the six sectors of a medium-sized specialized institution in the state of São Paulo. This sector, corresponding to early childhood education, had at the time of data collection about 70 students enrolled, aged 2–14 years, divided into 10 classes. The sector had invested in the purchase of equipment and high-tech assistive devices and sought the university to provide training of its professionals in the processes of implementation.

Participants

The participants were a school-level coordinator, five technicians (two speech therapists, two physiotherapists, a psychologist—hereafter referred to as T1 to T5, respectively) plus ten teachers (hereafter referred to as P1 to P10). Each technician formed a collaborative duo with two teachers (hereafter referred to as duo A composed by T1 and P1; duo B by T2 and P2; duo C T3 and P3; duo D T4 and P4; duo E T5 and P5; duo F T1 and P6; duo G T2 and P7; duo H T3 and P8; duo I T4 and P9; duo J T5 and P10). A total of ten duos were formed; participants were given the option of working alongside professionals based on the assumption that collaborative consulting would proceed from the establishment of partnerships between professionals from different fields, and teachers who work directly with students.

The technical group was on average aged 36.2, ranging between 28 and 48 years. The ages of the teachers ranged from 28 to 45 years, averaging 34.4 years. All teachers had undergone initial training courses and/or continued training in the field of special education and/or inclusive education.

For the practical part of the training program, ten students with cerebral palsy (referred to as A - J) also participated; students were selected freely by each duo. The average student age was 9.4, ranging between 4 and 14 years. Regarding the level of motor impairment of the students, all of them were classified between levels III and IV on the Gross Motor Function Classification System (Silva, Pheifer, & Funayama, 2010), which indicated the need for implementation of assistive technology devices for carrying out daily activities.

Equipment

High-tech assistive technology equipment, which existed either in the school institutions or in the university, were used (e.g., pressure switchers, adapted computer mice, devices powered via a system in which the pull of a shoelace drives the electric impulse that moves the mouse and other electronic equipment, trackballs, touch-sensitive keyboards, software to build communication boards). To collect videotaped data, a digital camera was used.

Procedures

The study design involved six stages, namely: Preliminary Step - Driving ethical procedures; Step I - initial diagnosis phase of the use of assistive high-tech features by the study of participant characterization, the use of high-tech assistive devices, the identification of training needs of this sector and characterization of prior knowledge about assistive technology devices by participants; Step II - Development of the training program with the following goals: teaching how to use the computer to provide a better education according to the needs and abilities of students; teaching how to operate assistive high-tech equipment; teaching how to select the best equipment in light of the specific characteristics of each student; teaching how to prepare computer activities; teaching other forms of student assessment in context, through activities mediated by the computer, and teaching ways to implement more effective communication with students, via computer; Step III - Implementation of the training program; Step IV - Evaluation of the Training Program from collecting social validity measures of the program, comparing participants' knowledge before and after the program, and evaluating the program based on objective responses; Step V- Practices Maintenance Tracking to ensure the maintenance of change and promote the gradual withdrawal of the field researcher. Each of these steps had specific data collection tools and analysis procedures as described in Table 1.

Table 1
Design Steps: Objectives, Procedures for Data Collection and Analysis

PHASE	Data collection procedure	Data analysis procedure	Categories and subcategories derived from data analysis procedure
Phase I – Initial diagnosis phase	- Participant characterization file	- Participant Descriptions	
	- Semi-structured interview script: coordinator for the sector - Initial Evaluation script	- Compilation and description of the information about using computer and assistive technology devices and demands of training in the sector - Content analysis of reports aimed at compiling and verbal description of prior knowledge of computer devices of TA demonstrated by participants	- Assistive Technology Concepts; - Knowledge of high-tech assistive devices; - Using the computer as assistive technology device and its use in daily practice; - Collaborative work between technicians and teachers to promote the use of computers; - Feasibility of computer use with students with cerebral palsy.
Phase III – Training program implementation	- Filming of lectures	- Information compilation to describe the program implementation process.	
	- Filming sessions of practical activities - Researchers' field diaries - Field diaries of participants	- Content analysis of the recordings and diaries to describe the evolutionary process of each pair based on the categories: environment, devices, activities, positioning	- Student intervention (Devices; Posture; Environment; Activities) - Collaborative practice (Partnerships with duos; Partnerships with the researcher)

	- Final group interview guide	- Content analysis of responses	- Program evaluation (theoretical meetings: the content taught, hand materials, teaching employed, supervised practices: proposed activities, difficulties, and positive aspects) Continuity expectations, practices in the industry; (Difficulties; Features)
Phase IV – Training program formal evaluation	- Final questionnaire on knowledge about assistive technology	- Comparison of the contents of the responses of the participants before and after the program	- Collaborative practice: positives and negatives: - (With duos; With the researcher) - Assistive Technology Concepts - Knowledge of high-tech assistive devices; - Using the computer as assistive technology device and its use in daily practice
	- Quantitative program evaluation script	- Quantitative analysis of evaluative responses of the aspects of the training program	- Collaborative work between technicians and teachers to promote the use of computers; - Feasibility of computer use with students with cerebral palsy.
Phase V – Maintenance	- Field diaries of subsequent visits after the first year of intervention (often two to three times a week, lasting an average of two hours).	Content analysis of the daily activities in order to assess whether or not changes are being maintained	- Room reorganization;
	- Analysis of documents Annual Planning Guides, built by each teacher for his class of students		- The use of computers and other assistive technology devices; - Strategies for the use of devices throughout the year in planning; - Collaborative work with the other professional

The training program (Phase III) involved seven theory-based meetings with all participants, as well as concomitant interventions, situation simulations, supervision, and feedback on practical aspects of implementation of the features for students with cerebral palsy and professional duos. The average meeting with each threesome (A–J, formed by the professional duo and one student) was 36 sessions, ranging between 14 and 49, at a minimum of 40 minutes each. Specifically, to facilitate collaborative work, two major partnerships have been built into the training program: one between the researcher and the participants, and the other between the technical staff and the teachers.

The teaching objectives established for both the duos as to target students varied due to differences between the ages of students, the degrees of motor impairment, the level of knowledge and experience of professionals in computer use, and the individualized educational plan (IEP) for each student. In general, all duos were involved in learning: a) to handle assistive technology devices available at the school, b) to evaluate students in order to indicate the use of access devices to the computer that were best suited to their capabilities, c) to implement the use of devices for target students, d) to create activities using the computer and access devices, and e) to evaluate teaching mediated by computers according to the teaching objectives for each student target. To target students, the objectives were learning the use of computer access devices and educational tasks.

The evaluation of the effectiveness of the program was carried out in Stages III, IV, and V and was based on two dimensions: 1. Evaluation of in-service training for the implementation of high-tech assistive technology devices and the maintenance of practices, from follow up data; 2. Evaluation of the collaborative work proposed.

Data analysis incorporated the triangulation of multiple data sources (Bratlinger, Jimenez, Klingner, Pugach, & Richardson, 2005). A trained researcher naive to the study aims analysed the videotaped records using the procedures described in Table 1 (Pinheiro, Kakehashi, & Angelo, 2002), and the written records were subjected to content analysis, with divisions into categories and subcategories (Table 1).

The conclusions summarized in Table 2 were built from multiple data collection sources: 1. evaluation of the implementation of high-tech assistive technology devices in each participant pair; 2. questionnaires about knowledge and changes in professional practices after the program; 3. the final reflections in participants' field diaries; 4. participants' ratings on a survey designed to measure their perceptions of the in-service program; 5. data from the final interviews with the participant duos; 6. additional program results of participants' training activities at the institution; 7. evaluation of maintenance practices in the institution at the time of follow up.

In order to evaluate the program along these dimensions we sought to examine, for professionals (technicians and teachers), the impact of the program in terms of advances in cooperation and advances in knowledge and implementation of assistive technology devices; and for students, the impact in terms of functionality gains that would increase participation and learning. An array was developed and data from different sources were considered, to determine whether there were advances, and along which dimensions. In accordance with the study object and analysis procedure, teams' results were produced around four parameters: benefits observed for the student using devices; learning of the participating professionals on device implementation; collaborative practice established between the duos; and maintenance of computer use and devices after the training program. Table 2 summarizes each team's results.

Table 2
Summary of Results for Duos (Professionals and Teachers)

Benefits observed for the student using devices	**Learning of the participating professionals on implementation of devices**	**Computer maintenance and use of devices after the training program**	**Collaborative practice established between the duos**
Implementation with functionality gain A; G; I	Independent practice A; B; F; G; I	Maintenance of device use A; B; E; G; I	Collaborative A; E
Implementation but no impact observed in students B	Autonomy in process C; E; H; J	Maintenance of partnerships A; B; C; I	Partly collaborative B; C; G; H; I
There was no implementation C; E; F; H; J		Without the use of maintaining high assistive technology devices C; F; J	No collaboration F; J

RESULTS

The results presented here are in reference to the 9 threesomes who completed the training program; one of the teachers (P4) changed classes during the study and was thus excluded from the analysis.

Below the results of the study on each of the above parameters are detailed.

IMPACT OF THE TRAINING PROGRAM ON THE CONFIDENCE AND USE OF ASSISTIVE HIGH-TECH FEATURES

The final entries in participants' field diaries were analysed in order to get data on their specific confidence from the use of the implemented devices. Data showed that nine participants and technical teachers said that they felt more prepared to work with their students using the computer and other equipment after participation in the program. However, data from the formal evaluation of the program indicated that, for the school staff, there were still feelings of insecurity around the handling of devices at the end of the program.

The training program was also evaluated as positively contributing to established practice and service in the final group interview, as illustrated in the following lines:

P6: "... it was really cool because by joining theory and practice we gain more."
T2: "...and the good thing is that we can already think of the children. Because the difficulty already existed. "

With regard to the confidence and changes in professionals' practices after the program, questionnaire data obtained indicated that there was an increase in knowledge about the high-tech assistive devices and their implementation processes; expectations for continued work next year; and expected difficulties due to routine service in the industry, including the nature of collaborative work:

> T2: "I think the greatest difficulty will be to maintain the activities on the computer. The hard part is doing some things we do not have time to do. "

IMPACT OF THE TRAINING PROGRAM ON COLLABORATION BETWEEN PROFESSIONALS

Considering the references used in the study, we sought to identify, through categories of analysis, the partnership between the duo itself and the researcher, related to working with a common purpose, to parity among professionals in the planning, to intervention and evaluation of strategies, and to voluntarism (Kampwirth, 2003).

With regard to the duos, we found that A and E had established effective collaborations, while duos B, C, G, and I developed partial collaboration. In duo B, T2 participated in only three sessions with the student, keeping this pair in the planning stage. In pair C, P3 and T3 maintained collaborative activities, but not throughout the course, because of incompatible schedules for the meetings, while duo L, who had collaborated during all course activities, did not have a steadily present student (T2). Duo H showed collaborative partnership between P8 and T3 during practical interventions, but not in planning activities. Finally, pair I performed suitable collaborative work and shared moments of planning and constructing activities, although T4 was not involved in the course of direct intervention with the student.

Through the practice analysis, it was found that duos F and H had not reached the stage of collaborative work. Importantly, these duos had exchanges and dialogues to fulfil the program tasks, but their changes were not sustained throughout practices and toward target students.

However, the appreciation of collaborative practice was present in the analysis of all data, since there was an appreciation of the collaborative model among both the researchers and the technical staff.

> T5: "I found it very good to exchange with the pair, but I think from now on [I will] no longer need the pair. Now we all have the same base. And it will facilitate [our progress]. The more activities you do, the more you get out."
>
> P5: "The work with the technical team is also very important because the exchanges guarantee the best progress and development of our students."
>
> T4: "I also learned that the participation of all staff in the preparation of activities with teachers is very important. And we must always draw objectives and strategies [together] before [implementation]."

MAINTENANCE PRACTICES

In order to assess maintenance of practices in the sector at the time of follow up, a total of 38 meetings were conducted and recorded. We also analysed the Annual Plans created by teachers in order to check if they planned to incorporate computer use in activities with students. It was observed from these data that some changes predicted at the end of the previous year had been realized, such as changing rooms and provision of equipment. There was a new teacher entering the sector, who took over the room that had belonged to P6 (target students F and G), including the content, computers and devices, in partnership especially with T2. We observed the maintaining of the incentive of computer use and assistive features both by teachers as well as by the technical team, regardless of what their study pair had done (this was observed among participants P1 and T1, T2 and P2, P3 and T3; P9 and T4). We also observed new educational programs on the computers of the rooms that allowed the use of drives. However, some difficulties related to the equipment itself remained during follow up, as some rooms' computers had to undergo maintenance for periods of time.

At follow up, the results indicated that teachers P1, P2, P5, and P9 kept up practice with the devices. These teachers showed more autonomous equipment use during the program, and the new teacher followed their suggestions to continue work with student G. No new activities were created, but those produced during the course were still being used, especially those carried out by P9. In other rooms, the computer came to be used only at specific times during the week, and the predominant use of traditional commercial educational children's software on these devices was noted.

All the analysed data indicated that, for participants, a lack of time for planning hindered the maintenance of new practices developed during the training program. However, the main difficulties encountered in generalizing the training program lessons to new students and teachers were related to three aspects of the institutional context, namely: 1) the routine of the institution; 2) absence of target students; and 3) equipment maintenance difficulty.

With regard to routine, the high number of activities to be performed daily by the teachers and technical staff often outweighed the opportunities for action on the computers. It was often necessary to reorganize workshops due to unforeseen events taking place in instructional rooms, such as unexpected changes in hygiene, time needed for extra classes (such as music, physical education, and dance); and cultural performance tests presented by the institution to students. In addition, room schedules were very intense, mainly due to the high levels of commitment that staff showed to most students, who required help with feeding and health activities. These activities seemed to overwhelm teachers, and to inhibit them from thinking about educational activities that required movement of students around the room, or searching for and installing equipment.

In this sense, the need to reorganize professionals' work routines was an evident first step in the planning of practical intervention programs. This was carried out in the planning stages of our intervention program. We started from the premise that there would be no successful implementation of assistive technology devices in an action plan being put in place. Additionally, our process reinforced the idea that new computer activities should be incorporated during teacher planning routines, with flexibility built in to accommodate several possibilities for how students may use this technology.

With regard to assistive equipment, difficulties occurred because the institutions' computers were the responsibility of an external technician, and all types of installations, configurations, or repairs depended on the schedule of this service. This caused some delays and postponements in practices involving the duos. Difficulties regarding the equipment have also been reported in Kleina (2008), which indicates the need for continued investment in working on computers and other technology in classrooms, as well as in more responsive technical services in schools.

IMPACT ON STUDENT PERFOMANCE

Data showed that only two of the nine duos were successful in getting to the assistive technology device implementation stage (duos A and G) resulting in benefits of the use of computers for student learning. Four of the duos realized that they needed more practice, but barriers related to serious visual impairments (duo J, duo E and duo C), or severe cognitive impairment (duo F) hampered the implementation of computer devices; this may have discouraged collaboration within the duos. For three of the ten duos, barriers to implementation were linked to operational difficulties in management of the institution, maintenance of computers in working condition in the sector (duos H and I), and difficulties due to having to remove a teacher from one sector because of health problems (duo D). Finally, in two cases, barriers were related to the constant absenteeism of students, which led to the discontinuation of the work of the duos B and I.

With regard to the students, the high absenteeism of some or the high level of commitment of others (students B, C, E, H, and J), resulted in joint decisions between participants and researchers, to modify the program practices. For example, some students received elaborated activities, or pair training on the use of other high-tech assistive devices.

Both A and I students learned to use the devices and continued to use it in the year following the study; in addition, these students were referred to the regular education school later in the year, and continued to receive specialized education in their new institution.

Although not all duos were considered to have successfully completed the program, benefits to these participants were nonetheless observed. For student G, for example, the use of devices promoted more autonomy in carrying out activities on the computer and in his communication, and the team decided to keep him in the institution sector for another year to ensure the continuity of his work and progress. In the case of student B, modest advances were observed in his understanding the functioning of devices (action and reactions with the computer), but there was still the need to maintain verbal and physical instructions to help him. In the cases of students C and F, devices were used as proposed at specific moments, but gains were observed when they were allowed to adapt these devices.

Activities involving the use of computers also helped to identify those students with cerebral palsy who had difficulties in sensory tasks (visual and auditory) as well as in verbal tasks. For three of the nine duos who had suspected sensory impairments, their difficulties were identified and confirmed after they attempted activities involving the use of computers (students C, E and J).

DISCUSSION

Thus, the program's goal was to teach professionals and teachers to work together to establish an implementation plan for assistive technology devices to improve the quality of education for cerebral palsy students. What has been observed is that the program had impacts at different levels between the professional-teacher duos, for example in collaboration between professionals, but not necessarily in the knowledge and use of devices. Even when the duos showed improvements in both respects, this did not always produce a positive impact on a student’s achievement.

It should be noted that inadequate preparation for an activity or a device can lead everyone involved (students, teachers, professionals, family) to frustration and disbelief in the possibility of autonomy, or even to the abandonment of these practices. This negative impact is identified as one of the main causes of disuse of assistive technology equipment. It presents losses for the user but also for the service that is invested in these technologies (Jutai et al., 2005; Philips & Zhao, 1993). Accordingly, care should be taken to prevent such failures.

Although the aim of any teacher training or continuing education program is to improve student outcomes, it was always made clear to the participants in this study that the purpose of the offered training program was to seek ways to better use computers with cerebral palsy students, regardless of whether computers were the most appropriate learning tool for each child. The duos defined the types of recommended devices for each student, and considering the objectives set out in the IEP, they established the tasks to be taught by the computer. This was a limitation of the study, not considered during training to interfere in the analysis of the adequacy of the student´s teaching objective, the selected task for the duo and the decision as to whether a computer would be the best tool to teach. Perhaps if appropriate tools had been used, the students might have been more successful and in turn, the professionals might have felt more successful and might have been more enthusiastic about continuing their efforts.

Inherent in this design was the ability to provide professionals with the tools and devices to understand and justify why a particular student might not achieve success through computer use, and what could be redesigned.

The results indicated that in fact, the complexity of the process of implementing assistive technology devices is often directly related to the demands of the target student, school dynamics around the targeted activities and the equipment itself (Dell, Newton, & Petroff, 2008). In addition to these variables that must be attended to, when proposing a service training program all the possibilities for exchanges among professionals should be taken into account, along with the constant construction of all the routes to be followed in working together harmoniously (Chambers et al., 2022; Cole & Knowles, 1993).

The intervention with the collaborative consulting model was chosen precisely because it was based on the sharing of responsibilities and knowledge of best care for the student, beyond the professional development of all (Kampwirth, 2003).

From the information collected in filmed observations at the target sector of the intervention and also via the accounts of participants, we learned that the work of technical staff and teachers was previously considered dichotomized. In other words, the technical staff were responsible for delineating objectives to be achieved with the students, but a lot of them were still on paper in certain areas. The decision to involve professionals in the technical teams with teachers provides exactly the complexity needed in evaluating the variables involved in choosing and using a high-tech assistive device (Chambers et al., 2022; Cook & Polgar, 2015; Karlsson, Johnston, & Barker, 2018;

Queiroz & Braccialli, 2017; Reed & Bowser, 2012) and following the assistive technology legal definition assumed in Brazil (Brazil, 2015).

We recognize that educators who are truly able to utilize assistive technology devices by using computers will fulfil their functions in the individual learning processes in their educational contexts. However, it is necessary that all professionals involved in these processes are able to support the implementation of these devices, and this requires theoretical and practical knowledge (Calheiros et al., 2017; Chukwuemeka & Samaila, 2020; Fernández-Batanero et al., 2022; White & Robertson, 2014).

Both the proposal for implementation of high-tech assistive devices and the content of the training program were intended to demonstrate the need to look at students globally, and to share responsibility for decisions regarding them. It is essential to emphasize that the success of the work was always determined by the attempts to use devices, by dialogue, and by thinking together, and not based on whether students really achieved autonomy in use (Hunt, 2021). This aspect of the program was clear even to participants, as shown by the social validity results of the training program.

Regarding collaborative partnerships with the researcher, the program was successful in showing participants how problems with assistive technology in their classrooms may be solved. Researchers and participants collaborated well, as did the threesomes composed of duos and students, so that productive discussions around potential problems and their resolutions took place; this was facilitated by several features incorporated into this study, including the formulation of the talks, field diaries and the final group interview (Cole & Knowles, 1993; Desgagné, 2007). In addition, this collaborative approach proved to be efficient in finding equalized decision-making on the use of high assistive technology devices within the program, something valued by participants.

CONCLUSIONS

The format of the training program was well rated by all participants, from the strategies used for delivering theoretical content, to the researchers' diary entries, to the work of the duos. During two years of data collection, the training process has shown the importance of carefully structuring practices in service training in special education, and in encouraging reasoning between staff, teachers, and the researcher. Training in collaboration based on reflections contributed to this; however, it should be noted that this was not enough to sustain new practices over time.

Through analysis of the courses of the nine duos in this study, we realized that the intervention sessions, especially with regard to opportunities to practice, were not sufficient to achieve the expected training goals of all professionals in the sector, and to have an impact on children's use of high-tech assistive features. New actions may be necessary to maintain the changes achieved through new practices, while broadening the educational planning skills, and promoting continued use of the computer by teachers and technicians in the medium and long terms.

The job of training educators on the use of computerized assistive technology devices in special education is not simple, since our program lasted two years, had the presence of a specialized consultant for participants with intensive presence in the institution, yet produced limited results. Given the complex nature and specialization that this kind of educational intervention requires, increasing the impacts of the program might not just be a matter of increasing program time, but instead might require providing permanent support specialists in educational institutions.

Thus, future research should investigate the possibility that, in the case of implementation of computerized assistive technology devices, hiring a professional expert in this area may provide permanent and continuing education to ensure the maintenance of new practices.

We understand that there is no one-size-fits-all training program, as there are many variables that influence the practice of professionals in special education. The diversity of backgrounds, composition of classrooms, and characteristics of students present in this study alone indicate the complexity inherent in proposing continuing education experiences that are not based on the specific needs of each school context. In this experiment, the unique experiences of each pair showed that the process of development and change in practices is very personal and occurs under particular time-space conditions for any given teacher, with a particular student, in a specific room.

In conclusion, it is worth noting that the evidence about the complexity of the type of training un.dertaken in this study allows us to question the effectiveness of courses in the country, designed to train teachers in the use of information and communication technologies and assistive technology devices in special education. These courses, mostly of short duration, and/or carried out remotely, with theoretical and/or practical components, are unlikely to be effective to ensure the implementation of these types of technologies that contribute to the education of students with disabilities in regular or special schools.

The means of building a quality education seems to be in providing ongoing in-service training, preferably within the same "ground school", to foster collaborative practices, and utilize the institution's own expert professionals, and to ensure the maintenance of good practices and the continued use of technological devices.

AUTHORS CONTRIBUTION

Conceptualization: G.F.L. and E.G.M.; Methodology: G.F.L and E.G.M.; Investigation: G.F.L and E.G.M.; Data Curation: G.F.L.; Writing – Original Draft Preparation: G.F.L.; Writing – Review & Editing: E.G.M.; Supervision: E.G.M.; Funding Acquisition: G.F.L and E.G.M.

ACKNOWLEDGMENTS

The authors are grateful for the support of the funding agencies, Foundation for Research Support of the State of São Paulo (FAPESP), and the National Council for Scientific and Technological Development (CNPq).

REFERENCES

Abu-Alghayth, K. (2022). Teachers’ use of assistive technology in Saudi special education schools: a mixes methods enquiry. *International Journal of Developmental Disabilities, 68*(4), 547-555.

Andrade, E. T., & Mendes, E. G. (2015). Comparative Study of School Inclusion Policy School for Students with Physical Disabilities in Three Brazilian Municipalities. *Education Policy Analysis Archives*, *23*, 32.

Bausch, M. E., Ault, M. J., Evmenova, A. S., & Behrmann, M. M. (2008). Going beyond AT devices: are AT services being considered? *Journal of Special Education Technology*, *23*(2), 1-16.

Brantlinger, E., Jimenez, R., Klingner, J., Pugach, M., & Richardson, V. (2005). Qualitative Studies in Special Education. *Exceptional Children, 71(*2), 195-207.

Brazil (2015). *Lei nº 13.146 de 6 de julho de 2015*. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência). Retrieved from: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm

Brazil/ Ministry of Education. SEESP/MEC. (2007a). *Atendimento educacional especializado:* deficiência física. Brasília: MEC. 129 p. Retrieved from: http://portal.mec.gov.br/seesp/arquivos/pdf/aee_df.pdf

Brazil/Ministry of Education. (2007b). *Ata da VII Reunião do Comitê de Ajudas Técnicas.* Retrieved from: https://www.assistiva.com.br/Ata_VII_Reuni%C3%A3o_do_Comite_de_Ajudas_T%C3%A9cnicas.pdf.

Brazil/ Ministry of Education. (2008). *Decreto nº 6.571 de 17 de setembro de 2008.* Dispõe sobre o atendimento educacional especializado. Retrieved from: http://portal.mec.gov.br/arquivos/pdf/decreto3956.pdf

Brazil/ Ministry of Education. (2009). *Resolução nº4 de 2 de outubro de 2009*: Institui as Diretrizes Operacionais para o Atendimento Educacional Especializado na Educação Básica, modalidade Educação Especial. Retrieved from: http://portal.mec.gov.br/dmdocuments/rceb004_09.pdf

Calheiros, D. S., Mendes, E. G., & Lourenço, G. F. (2017). Considerações acerca da tecnologia assistiva no cenário educacional brasileiro. *Revista Educação Especial, 1*, 1-12.

Campbell, P. H., Milbourne, S., Dugan, L. M., & Wilcox, M. J. (2006). A review of evidence on practices for teaching young children to use assistive technology devices. *Topics in Early Childhood Special Education*, *26*(1), 3-13.

Chambers, D., Jones, P. J., Reese, L., & Wilcox, C. (2022). Teachers' perspective of what works: implementation of AT for students with disabilities. *Assistive Technology, 34*(3), 352-361.

Chukwuemeka, E. J., & Samaila, D. (2020). Teachers' perception and factors limiting the use of high-tech assistive technology in special education schools in north-west Nigeria. *Contemporary Education Technology, 11*(1), 99-109.

Cole, A., & Knowles, J. G. (1993). Teacher development partnership research: a focus on methods and issues. *American Educational Research Journal*, *30*(3) 473-495.

Cook, A. M., & Polgar, J. M. (2015). *Cook and Hussey's Assistive Technologies: Principles and Practice*. St. Louis, MO: Mosby.

Copley, J., & Ziviani, J. (2004). Barriers to the use of assistive technology for children with multiple disabilities. *Oc. Ther. Inter.*, *11*(4), 229-243.

Desgagné, S. (2007). O conceito de pesquisa colaborativa: a idéia de uma aproximação entre pesquisadores universitários e professores práticos. *Revista Educação Em Questão*, *29*(15), 7-35.

Dell, A. G., Newton, D. A., & Petroff, J. G. (2008). *Assistive technology in the classroom: enhancing the school experiences of students with disabilities*. New Jersey: Pearson Education Inc.

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J. et al. (2022). Assistive technology for inclusion of students with disabilities: a systematic review. *Educational Technology Research and Development,* 1-20.

Hunt, P. F. (2021). Inclusive education: the case for early identification and early intervention in assistive technology. *Assistive Technology, 33*(sup1), S94-S101.

Imamura, E. T. M. (2008). *Formação continuada do professor para o uso dos recursos de informática com alunos com deficiência física*. (Dissertação de Mestrado em Educação - Ensino na Educação Brasileira). Universidade Estadual Paulista, Marília, Brazil.

Jutai, J, Fuhrer, M. J., Demers, L. et al. (2005). Toward a taxonomy of assistive technology device outcomes. *American Journal of Physical Medicine Rehabilitation, 84*(4), 294-302.

Kampwirth, T. J. (2003). *Collaborative consultation in the schools: effective practices for students with learning and behavior problems*. New Jersey: Pearson Education.

Karlsson, P., Johnston, C., & Barker, K. (2018). Influences on students' assistive technology use at school: the views on students' assistive technology use at schools: the views of classroom teachers, allied health professionals, students with cerebral palsy and their parents. *Disability and Rehabilitation: assistive technology, 13*(8), 763-771.

Kleina, C. (2008). *Formação continuada de professores para o uso de informática e tecnologias assistivas para alunos com deficiência física*. (Dissertação de Mestrado em Educação). Pontifícia Universidade Católica do Paraná, Curitiba, Brazil.

Lahm, E. A., & Sizemore, L. (2002). Factors that influence assistive technology decision-making. *Journal of Special Education Technology*, *17*, 15-25.

Manzini, E. J. (2009, September). Formação de professores e tecnologia assistiva. Proceedings of *V Seminário Nacional de Pesquisa em Educação Especial*. São Paulo, SP, Brazil.

Mendes, E. G., & Lourenço, G. F. (2012). Recursos computadorizados de tecnologia assistiva para estudantes com paralisia cerebral em múltiplos contextos. In E. G. Mendes & M. A. Almeida (Orgs.), *Dimensões pedagógicas nas práticas de inclusão escolar* (Volume 2, pp. 421-444). Marília: ABPEE.

Mendes, E. G., Marques, L. C., & Lourenço, G. F. (2012). A abordagem colaborativa em pesquisas na Educação Especial: aliando produção de conhecimento com formação e prestação de serviço. In E. G. Mendes & M. A. Almeida (Orgs.), *A pesquisa sobre inclusão escolar em suas múltiplas dimensões* (Volume 1, pp. 383-396). Marília: ABPEE.

Morrison, K. (2007). Implementation of assistive computer technology: a model for school systems. *International Journal of Special Education*, *22*(1), 83-100.

Phillips, B., & Zhao, H. (1993). Predictors of assistive technology abandonment. *Assistive Technology, 5*, 36-45.

Pinheiro, E. M., Kakehashi, T. Y., & Angelo, M. (2002). O uso de filmagens em pesquisas qualitativas. *Revista Latino-Americana de Enfermagem, 13*(5), 717-722.

Queiroz, F. M. M. G., & Braccialli, L. M. P. (2017). Funcionalidade de alunos com deficiência física nas atividades de escrita e de uso do computador. *Revistas Ibero-americana de Estudos em Educação, 12*(2), 1267-1286.

Reed, P., & Bowser, G. (2012). Consultation, collaboration, and coaching: essential techniques for integrating assistive technology use in schools and early intervention programs. *Journal of Occupational Therapy, Schools, & Early Intervention, 5*(1), 15-30.

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., Dan, B., & Jacobsson, B. (2007). A report: the definition and classification of cerebral palsy April 2006. *Developmental medicine and child neurology. Supplement*, *109*, 8-14.

Sagor, R. (1992). *How to conduct collaborative action research*. Vancouver: McLoughlin Boulevard.

Silva, D. B. R., Martinez, C. M. S., & Santos, J. L. F. (2012). Participação de crianças com paralisia cerebral nos ambientes da escola. *Revista Brasileira de Educação Especial, 18*(1), 33-52.

Silva, D. B. R., Pfeifer, L. I., & Funayama, C. A. R. (2010). *GMFCS – E & R Sistema de Classificação da Função Motora Grossa Ampliado e Revisto*. Retrieved September 15 2022 from: https://canchild.ca/system/tenon/assets/attachments/000/000/075/original/GMFCS-ER_Translation-Portuguese2.pdf

Watson, A. H., Ito, M., Smith, R. O., & Andersen, L. T. (2010). Effect of assistive technology in a public-school setting. *American Journal of Occupational Therapy*, *64*(1), 18-29.

White, D. H., & Robertson, L. (2014) Implementing assistive technologies: A study on co-learning in the Canadian elementary school context. *Computers in Human Behavior*, *51*(B), 1268-1275

*

Received: July 5, 2022

Revisions Required: September 2, 2022

Accepted: October 3, 2022

Published online: October 31, 2022