



# Use of modulated frequency system by hearing impaired school children

**Uso do sistema de frequência modulada por escolares com perda auditiva**

**La eficacia del uso del sistema de frecuencia modulada en escolares con pérdida auditiva**

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## **Abstract**

**Introduction:** inclusion along with accessibility and new technologies are aspects that are interconnected from the perspective of intervention with the hearing impaired. As an accessibility strategy, there is the system of modulation frequency (FM), which enables the perception of the targeted sounds.

**Objective:** verify the monitoring of FM system users. **Method:** this is a descriptive, quantitative and cross-sectional study. A differentiated questionnaire was applied for each segment involved with FM: students, teachers and legal guardians. The data were stored in Excel spreadsheet and a descriptive analysis was carried out, using percentage tables and graphs. **Results:** the use of the FM system provided accessibility in relation to communication between students with hearing impairment, parents and teachers; 77.77% of the students showed improvement in school performance after use. In addition, 72.22% said they listened well to the teacher. With regard to parents, 78.94% reported improvement in their child's school performance. It was also evidenced the teachers' lack of preparation in relation to inclusive education and the adaptation of methodologies directed to the educational demand. In which, 51.51% reported that they do not feel prepared to meet this demand. **Conclusion:** the use of the FM System demonstrated benefits within the school context, allowing the improvement of the perception of speech in noisy environments according to the conceptions of the groups. Educational institutions need to take actions directed to inclusive practices in the area of auditory accessibility, in order to promote teacher training.

**Keywords:** Hearing aids; Hearing impairment; Inclusion; Deafness.

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## Resumo

**Introdução:** a inclusão em conjunto com a acessibilidade e as novas tecnologias são aspectos que se encontram interligados sob a ótica da intervenção voltada a pessoas com deficiência auditiva. Como estratégia de acessibilidade, o sistema de frequência modulada (FM), possibilita a percepção direcionada dos sons. **Objetivo:** verificar o uso do sistema FM por escolares com perda auditiva. **Método:** trata-se de um estudo descritivo, quantitativo e transversal. Foi aplicado um questionário específico para cada segmento envolvido com o sistema FM: estudantes, professores e responsáveis legais. Os dados foram armazenados em planilha do programa Excel e foi realizada uma análise descritiva, por meio de quadros e gráficos percentuais. **Resultados:** o uso do sistema de FM proporcionou a acessibilidade em relação à comunicação entre os alunos com deficiência auditiva, pais e professores. Os estudantes apresentaram melhora no desempenho escolar após o uso do sistema de FM (77,77%). Além disso, eles afirmaram ouvir bem o professor (72,22%). Já os pais, por sua vez, relataram melhora no rendimento escolar do filho (78,94%). Evidenciou-se também o despreparo dos professores em relação à educação inclusiva e à adaptação de metodologias direcionadas à demanda educacional. Os professores relataram que não se sentem preparados para atender a essa demanda (51,51%). **Conclusão:** o uso do sistema de FM pelos estudantes no ambiente educacional está relacionado à melhora da percepção da fala em ambientes ruidosos, conforme as concepções dos estudantes, pais e professores. As instituições de ensino necessitam realizar ações direcionadas às práticas inclusivas na área da acessibilidade auditiva, bem como promover ações voltadas à capacitação do corpo docente.

**Palavras-chave:** Auxiliares de audição; Deficiência auditiva; Inclusão; Surdez.

## Resumen

**Introducción:** la inclusión junto con la accesibilidad y las nuevas tecnologías son aspectos que se interrelacionan bajo la óptica de la intervención con los deficientes auditivos. Como estrategia de accesibilidad, hayel sistema de frecuencia modulada (FM), que possibilita la percepción de los sonidos dirigidos. **Objetivo:** verificar el seguimiento de los usuarios del sistema FM. **Método:** Se trata de un estudio descriptivo, cuantitativo y transversal. Se aplicó un cuestionario diferenciado para cada segmento involucrado co nel FM: estudiantes, profesores y responsables legales. Los datos fueron almacenados en la hoja de cálculo del programa Excel y se realizó una análisis descriptiva, através de cuadros y gráficos de porcentaje. **Resultados:** el uso del sistema FM proporcionó accesibilidad en relación a la comunicación entre alumnos com deficiencia auditiva, padres y profesores. Enelcual, 77,77% de los estudiantes mostró mejoría en el desempeño escolar después del uso. Además, el 72,22% afirmó escuchar bien al profesor. Enlo que respecta a los padres, el 78,94% relató mejoría en el rendimiento escolar del hijo. Se evidenció también el despreparo de los profesores en relación a la educación inclusiva y a la adaptación de metodologías dirigidas a la demanda educativa. Enel que el 51,51% relató que no se sienten preparados para atender a esta demanda. **Conclusión:** el uso del sistema FM demostró beneficios dentro del contexto escolar, posibilitando la mejora de la percepción de lhabla en ambientes ruidosos conforme a las concepciones de los grupos. Las instituciones de enseñanza necesitan realizar acciones dirigidas a las prácticas inclusivas en el área de la accesibilidad auditiva, a fin de promover capacitaciones del cuerpo docente.

**Palabras claves:** Auxiliares de audición; Deficiencia auditiva; Inclusión; Sordera.



## Introduction

The admission of hearing impaired children in school remains challenging. The National Policy on Hearing Health Care provided access to technological resources, such as the Personal Sound Amplification Products (PSAPs), the cochlear implant (CI) and the frequency modulation (FM) systems. In addition to contributing significantly to a better social interaction these hearing aid devices are important tools during the educational process. Such electronic devices are important not only for the technological innovations that they provide, but also because they are offered by the Unified Health System (SUS).<sup>1,2</sup>

The National Policy on Education provides the school inclusion of hearing impaired children or with other impairments that may affect the learning process, by guiding the educational institution to ensure, among other factors, the access to regular education, participation and learning, the provision of specialized educational services and the training of teachers to work in this environment. The PSAP and IC users are among the group of students with disabilities. Students with hearing loss should be included in the same group of non-hearing impaired students, thus being able to learn and participate, without any discrimination or distinction within the educational environment. In addition, an equal communication must be provided to hearing impaired students and non-hearing impaired students.<sup>2,3</sup>

People with hearing loss who developed the oral language typically use PSAP and/or IC. These technologies amplify both the sound the user wants to hear, as the voice of the teacher, in this case, and also the sound of the school environment, such as of chairs being dragged, the colleagues talking and the fan. The difficulty of hearing impaired students using PSAPs and/or IC also is present with respect to the understanding of sound stimuli in noisy environments. In this way, even the student who uses a PSAP and/or IC may not be able to understand the message in its entirety. The need to offer the FM system in the SUS was noticed from this complaint.<sup>4</sup>

The FM system is another electronic device that is used in the accessibility of hearing impaired people, being very important in the academic environment, since it allows the student to perceive the voice of the teacher in the classroom, regard-

less of distance and ambient noise. Thus, the use of the FM system enables the accessibility in the school context, as it provides better conditions for communication and interaction between colleagues and teachers.<sup>5,6</sup>

The FM system works as a wireless microphone for the PSAP and/or IC. It consists of two parts: a transmitter and a receiver. Teachers also have an important role in addition to this technological apparatus, which aims to contribute to the inclusion of the hearing impaired person in the academic context.<sup>7,8</sup>

Teachers are key mediators, responsible for making use of the FM system. It is vital that teachers and parents know how to handle and encourage the student to use these electronic devices. Therefore, it is essential the adhesion not only of the family, but also of the teachers who deal with student who use such resource for accessibility of oral communication.<sup>9</sup>

Hearing impaired students spend more time in the classroom than in the therapy room. In this way, the educational institution and the professionals who are responsible for the education of these students must be prepared and qualified to promote teaching strategies in order to facilitate the learning process, including with hearing aids, such as the FM system.<sup>1,10</sup>

In this context, this study aims to contribute to the discussion on inclusion in the school context, in order to verify the use of the FM system by students with hearing loss.

## Method

This is a descriptive, quantitative and cross-sectional study. This research was approved by the Research Ethics Committee, under the number CAAE 58365416.0.0000.5011. Subjects were invited to participate through contacts provided by two non-governmental organizations (NGOs) that distribute the FM system.

First, a telephone and/or personal contact was made with legal guardians and teachers of the FM system users. Those who accepted to participate in the research signed the Free and Informed Consent Term (FICT) and the Free and Informed Assent Term (FIAT). Upon the authorization, the researchers then went to the education units of students to carry out the data collection. Thus, the



study included 20 students who were FM system users, 19 legal guardians and 33 teachers.

The following inclusion criteria were adopted: students of both genders, aged from 5 to 17 years, with hearing impairment and FM system users, as well as their respective legal guardians and teachers linked to the educational institution. Exclusion criteria were as follows: hearing impaired subjects who received the FM system but were not enrolled in an educational institution.

A questionnaire was administered to each group of participants. The first research group was composed of FM system users, students from nursery school to the third year of high school; the second group, consisted of the legal guardians of these students; and the third group was composed by teachers who are in daily contact with these users.

A different questionnaire was proposed for each research group, which presented different questions according to the group (i.e., students, parents and teachers). The questions were prepared by the researchers and adapted from other researches in the field. The questionnaire for parents was based on the Portuguese version of the Early Listening Function (ELF)<sup>11</sup> protocol and on the questionnaire that was used in a study that aimed to know the level of perception and participation of family members regarding the school inclusion of children with cochlear implants.<sup>12</sup> As for teachers, questions were based on the questionnaires of the master's thesis that evaluated the "Modulated Frequency System Course for Teachers" website as a training tool.<sup>13</sup> And in the course completion work that investigated the inclusion of hearing impaired children in early childhood education emphasizing the role of teachers in this field.<sup>14</sup> Finally, the questionnaire provided to students was prepared based on the FM Listening Evaluation for Children: adapted to the Portuguese language<sup>15</sup> and in a monograph that aimed to indicate the importance and to identify the factors that impact the inclusion process.<sup>16</sup> All questionnaires applied to the sample consisted of 11 questions, being objective and subjective ques-

tions for teachers and only objective questions for parents and students, in order to verify the routine and the use of the FM system.

In the questionnaire to users, the main purpose was to observe the effectiveness regarding the use of the device within the school context, that is, whether it was contributing significantly to the school performance of the user or not. As for the legal guardians, it was used to check if they noticed some relevant improvement in the behavior and performance of the child after the use of this device in the classroom. The questions for teachers were related to their training, professional experience and the most used strategies within the perspective of inclusion of the students using the FM system. The data were stored in Excel spreadsheet and a descriptive analysis was carried out, using percentage tables and charts.

## Results

Although the group consisted of 20 children and adolescents, only 18 participated in the analysis, because two of them were unable to answer to the questions, due to restricted understanding and communication skills.

With respect to the 19 legal guardians, 17 were mothers, one was a father and the other one was a sister. More than one teacher answered to the questionnaire with respect to some students, so the group consisted of 33 teachers. It is worth mentioning that most of the students (N=11) attended public schools.

According to the data shown in Table 1, it could be noticed that 77.77% (N=14) of the students used the FM system for two or more years, and the same percentage showed improvement in school performance after using it. According to 61,11% (N=11) of the sample, adaptation to it was easy and 94,44% (N=17) reported to notice a difference in sound quality. In addition, 72.22% (N=13) reported that they listened well to the teacher speaking or explaining the lessons.

**Table 1.** Analysis of the contribution of the FM system in relation to students' school performance

QUESTIONS	ANSWERS		
How long have you been using the FM system?	< 1 years 11.11% (N=2)	1 to 2 years 11.11% (N=2)	> 2 years <b>77.77%</b> <b>(N=14)</b>
Did you notice any improvement in your school performance with the use of the FM system?	Yes <b>77.77%</b> (N=14)	A little 16.66% (N=3)	No 5.55% (N=1)
How was your adaptation when you started using the FM system?	Hard 38.88% (N=7)	Easy 61.11% (N=11)	-
Did you notice any difference in sound quality, that is, do you believe that the FM system has improved the quality of the sound that you hear?	Yes, a lot <b>94.44%</b> (N=17)	Not really 5.55% (N=1)	No -
Can you listen well to your teacher speaking or explaining the lesson?	Yes <b>72.22%</b> (N=13)	Sometimes 22.22% (N=4)	No 5.55% (N=1)

As shown in Table 2, 78.94% (N=15) of the legal guardians reported that they noticed an improvement in the school performance of their children's, and 84.21% (N=16) reported to encourage their child to use and to be careful with the FM system, while 36.84% (N=7) reported that their home is the environment in which their children present a better interaction. With respect to the com-

munication, 63.15% (N=12) of the sample believe that there was an improvement after the use of the FM system. Furthermore, 94.73% (N=18) had no difficulty in using the device. It is noteworthy that one of the parents that participated in the study was responsible for two subjects of the research. Thus, there were only 19 legal guardians in the analysis.

**Table 2.** Parents' opinion with respect to the behavior and performance of the child after the use of the FM system in the classroom

QUESTIONS	ANSWERS			
After using the FM system, have you noticed any improvement in your child's school performance?	Yes <b>78.94%</b> <b>(N=15)</b>	Not really 21.05% (N=4)	Nothing changed -	-
Do you encourage your child to use and take care of the FM system?	Always <b>84.21%</b> <b>(N=16)</b>	Sometimes 5.26% (N=1)	Only when required 10.52% (N=2)	Never -
In your opinion, in what environment does your child interact better?	At school 31.57% (N=6)	At home <b>36.84%</b> (N=7)	At shopping -	Anywhere 31.57% (N=6)
What skill do you believe that your child develops best after using the FM system?	Reading 10.52% (N=2)	Writing 15.78% (N=3)	Communication 63.15% (N=12)	Other 10.52% (N=2)
Since it is still a new technology and many people still do not know how to use it, have you faced any difficulty using the FM system?	No difficulty at all 94.73% (N=18)	Some difficulty 5.26% (N=1)	-	-



As for the results obtained from the analysis of the data shown in Table 3, the teachers' responses indicated that 63.63% (N=21) of them worked with hearing impaired students for over a year. Only 9.09% (N=3) had more than five years of experience. 78.78% (N=26) of the teachers did not have a specialization course or did not have a professional qualification related to inclusion and

educational accessibility. However, 21.21% (N=7) of them had a differentiated training, as, according to them, they had to seek support for this type of self-interest demand, and 69.69% (N=23) related that the communication was not difficult with these students. Nonetheless, 21.21% (N=7) reported that they had some difficulty, since students were not used to the daily use of the device.

**Table 3.** Teachers' responses to the use of the FM system, professional experience and effectiveness of strategies applied in the classroom

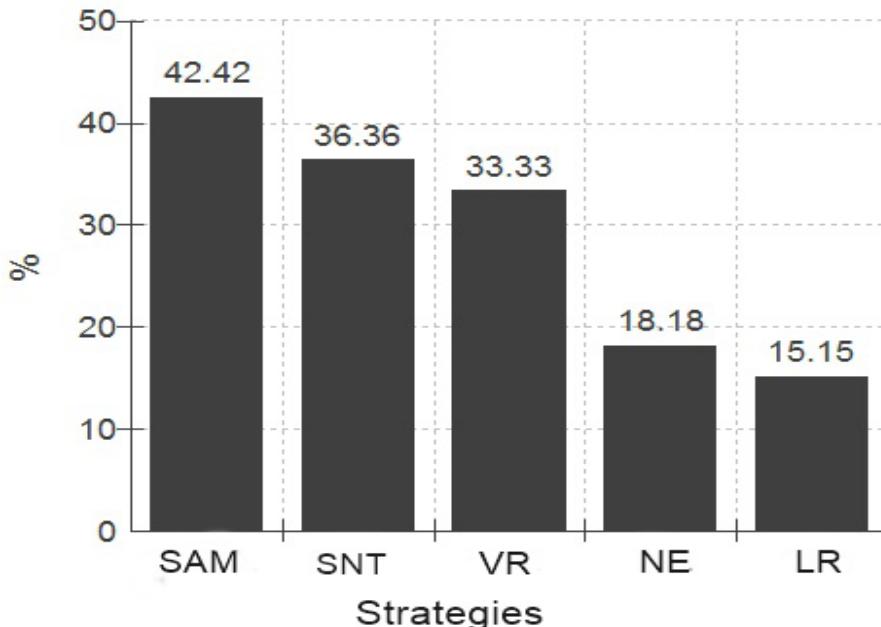
QUESTIONS	ANSWERS		
How long have you been working with hearing impaired people?	< 1 year 27.27% (N=9)	1 to 2 years 63.63% (N=21)	> 5 years 9.09% (N=3)
Did you attend any specialization or qualification course involving inclusion and accessibility?	Yes 21.21% (N=7)	No 78.78% (N=26)	-
Is communication difficult between you and your FM system user student in the classroom?	Yes 21.21% (N=7)	Sometimes 9.09% (N=3)	No 69.69% (N=23)
In your opinion, do the strategies undertaken help in student's understanding/performance?	Yes 72.72% (N=24)	Not always 15.15% (N=5)	No 12.12% (N=4)
As a teacher of hearing impaired students, do you feel prepared to meet educational needs and promote inclusion within the classroom?	Yes. I believe that I'm well prepared 33.33% (N=11)	Yes. but I found some difficulties 15.15% (N=5)	No. I don't think that I'm well prepared <b>51.51%</b> (N=17)

The strategies that they used help in the understanding and school development of students. According to the analysis, 72.72% (N=24) of them answered that the strategies undertaken do help in student's understanding/performance, while 15.15% (N=5) reported that sometimes it was not a solution and 12.12% (N=4) reported that they did not notice any help in the understanding of the students, as they indicated that they were not qualified to prepare specific and directed strategies.

Regarding the preparation of teachers with respect to educational needs and to the promotion of the inclusion of these students in the classroom, it was noticed that 51.51% (N=17) of the participating teachers believe that they are not prepared or

qualified enough to meet the educational needs of hearing impaired students.

According to data presented in the chart of Figure 1, the most used strategies by teachers in order to promote the accessibility of hearing impaired student who were FM system users in descending order were: specific and adapted materials (42.42%; N=14), sitting next to the teacher (36.36%; N=12), visual resources (33.33%; N=11), and lip reading (15.15%; N=5). Teachers who haven't used any strategy amounted to 18.18% (N=6). Furthermore, it should be noted that teachers were free to employ more than one strategy, so there were teachers who used up to three strategies as a teaching resource.



**Figure 1.** Strategies used by teachers to provide accessibility of hearing impaired students who are FM system users: specific and adapted materials (SAM), sitting next to the teacher (SNT), visual resources (VR), lip reading (LR) and no strategy (NE)

## Discussion

Data shown in Table 1 suggested that the use of FM system in the school context provided better performance to students in classroom activities. This finding corroborates with the literature,<sup>5,7,17</sup> given that studies show the advances related to the benefits of using this type of device, improving the auditory perception of some sounds and the communication of the students not only in social and familiar environment, but also in the school environment.

These benefits contributed to the improvement of sound quality, thus allowing the student to listen better to the teacher's explanation and also enabling a quality in communication and a breakthrough in school performance. It should be noted that only one student reported that he had no significant improvement in sound perception or in school development. This can be attributed to the fact that most of the time this student does not use his FM system in the classroom.

According to some authors, this objection to the use of the FM system can often be related to the negation caused by shame, believing that the

PSAP/IC does not work and/or by the difficulty of accepting to be different in relation to listening. In addition, it can be concluded that some factors, such as the constant noise of the classroom and the fear of taking the hearing aid device to school, contributed significantly to the non-acceptance of its use.<sup>10-17</sup>

A study was conducted in 2017 in São Paulo in order to check the use of the FM system and its benefit in CI users. To this end, an investigation was carried out through medical records of 113 IC users adapted with FM system kits. The study participants presented significant improvements with the use of the FM system, with a noticeable improvement in both the speech perception in noisy environments and the understanding of the teacher in the classroom.<sup>17</sup> Such findings are related to the data of this research, in which the use of the FM system was a key factor for the accessibility of the students involved.

Another research was conducted in 2015 in order to evaluate the effectiveness of the FM system in a case of unilateral malformation. In that case, the study concluded that the FM system favored speech perception and the participation of the subject in

the classroom. In addition, the authors reported that the FM system is a key tool in the school environment, since it enables the user to better access to information that is being instantly directed to his/her hearing aid device.<sup>18</sup>

Another study was published in 2014 in order to check the evolution of auditory perception of speech in children using PSAPs and/or CIs after the use of a FM system. It could be noted that all individuals in the sample showed a significant improvement in speech perception in all situations,<sup>19</sup> once again contributing to the findings of this study.

As shown in Table 2, it was detected that the use of the FM system is important for the parents, since the children's school performance has evolved significantly. These data corroborate the findings in Table 1, where subjects had the same perception regarding this issue, in which 77.77% (N=14) reported that their school performance improved. In this way, it is possible to notice that the FM system did provide a significant improvement in the studied population, which may be evidenced both in the opinion of the legal guardians and in the subjects.

The FM system is a device that offers an improved audibility of the speech of the interlocutor in inappropriate acoustic conditions, as in very noisy places.<sup>20</sup> From this perspective, the participants presented an improvement in the school performance, since the FM system eliminated the background noise in the classroom and directed the teacher's speech, which allowed a more accurate transmission of the information.

In addition, most parents/participants reported noticing an evolution in the communication skills of their children. According to a study conducted in 2004, hearing impaired individuals will be able to have an improvement in their communication skills only with the adaptation of PSAPs or ICs combined with the use of FM system.<sup>21</sup> This was clearly demonstrated in the research, since 63.15% (N=12) of the parents reported that their children had an improvement in their communication skills after the use of a FM system.

This perception of parents is more evident when there is family involvement in the school context. It is crucial that parents are aware about the development of their children, especially at school, as it is where the child spends most of the time and where academic learning happens.<sup>12-22</sup>

As shown in Table 3, most of the participating teachers work with hearing impaired students for over a year. Regarding teacher training, 78.78% (N=26) of the teachers did not attend any kind of specialization or qualification involving methodologies for the specialization or professional qualification related to the inclusion and accessibility of hearing impaired. According to the literature, teachers are not prepared to this type of demand. Thus, the methodology applied is often not effective, which, therefore, ends up affecting the learning process of students.<sup>23,24</sup>

However, a study conducted in 2015 reports the experience of teachers who have been trained by a team that was part of a school inclusion project, whose main objective was to train education professionals on the use of FM system. This research found that the training process of these professionals resulted in a number of benefits in relation to the knowledge of FM handling, as well as a better autonomy and confidence in designing methodologies of inclusive practices in the educational scope. Therefore, there was a breakthrough in the process of school inclusion of hearing impaired students who used the FM system in the institution involved.<sup>25</sup> In this way, it highlights the need to qualify the teaching staff to better serve this student population.

Some teachers reported no experience with hearing impaired students and FM system users. This fact may be related to the lack of training of such professionals, caused by the lack of incentive of the institutions. One of the issues directed to teachers was related to their use of communication strategies with their hearing impaired students. As communication strategies are key factors for obtaining the academic development of the student, this question was selected.<sup>1</sup>

According to the chart of Figure 1, 18.18% (N=6) of teachers do not use any specific communication strategy. This may be due to the lack of professional training of teachers and the entire teaching staff.<sup>26</sup> 'Sitting next to the teacher' was one of the most used strategies. It can be suggested that a shorter distance to the sound source favors the device, but it does not mean that the student will have access to the information and that he/she will understand the contents. Strategies that facilitate the learning process through specific teaching materials (with more visual content) should be designed.<sup>26</sup>



According to data, 51.51% (N=17) of the teachers reported that they do not feel prepared to attend to the educational needs of students, due to the lack of qualification and experience related to school inclusion. Numerous changes are needed in various contexts to enable the inclusion process. Educational institutions should provide better training of teachers in relation to educational methodologies and collaborative practices aimed at the needs of all students with or without a hearing impairment.<sup>27</sup>

Public and private schools must be prepared and qualified to work with the specific differences of these students, establishing a methodology that facilitates the learning process. In addition, the collaboration of parents in this process and the commitment of students to the use of technological resources that facilitate their school development are key factors.<sup>25</sup>

Thus, in order to advance in such aspects, educational institutions must establish a truly inclusive education, offering courses and training to teachers, so that the educational practices are directed to the educational needs of these students. In addition, lectures and workshops for parents are crucial to educate educators on the benefits of these technologies, which are essential for the learning process of students.

## Conclusion

The use of the FM System demonstrated benefits within the school context, allowing the improvement of the perception of speech in noisy environments according to the conceptions of the research groups. Educational institutions need to take actions directed to inclusive practices in the area of auditory accessibility, including the promotion of teacher training. It is important to highlight the importance of parental support in order to monitor the educational needs of the children and to encourage the use of electronic hearing devices in schools. It can be concluded also that there are still shortcomings in the training of teachers to work with inclusive practices and that educational institutions should be active in this process.

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