Educ Inf Technol (2016) 21:625–641
DOI 10.1007/s10639-014-9344-6

ICT in Portuguese reference schools for the education of blind and partially sighted students

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Published online: 22 July 2014

Abstract Technology has become an essential component in our society and considering its impact in the educational system, Information and Communication Technologies (ICT) cannot be dissociated from the educational process and, in particular, from pedagogical practices adopted for students who are blind or partially sighted. This study focuses on Portuguese reference schools for the education of blind and partially sighted students, regulated by the Decree-Law No. 3/2008, in which are concentrated the human and material resources that can offer an educational response with quality for these students with special education needs. The study intends to analyse the perceptions of the teachers, who teach visually impaired students in middle school and secondary school education in these reference schools, of their knowledge, teaching and training in the area of ICT, as well as of the real ICT integration in the teaching and learning of these students. A survey, which has been applied to these teachers in the 2012/13 school year, was adopted as a method of data collection. The results reveal a sample confident in their technological capabilities, however with little resourcefulness in some tools and software specific to the area of visual impairment and a very significant number of teachers ignoring many of these. The implementation of ICT with students who have visual disabilities is lower compared with the sighted students. The lack of specific training is considered to be the main obstacle for teachers, with regard to the real integration of ICT in the teaching and learning of these students.

Keywords Visual impairment · Information and communication technologies · Assistive technology · Teacher training · Portugal

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1 Introduction

The society we live in is called a Global Society and the constant evolution of Information and Communication Technologies (ICT) contributes to its change and development. Blindness is inevitably associated with several limitations with regard to electronic accessibility and individuals with visual impairment, that is, those who are blind or partially sighted, cannot be excluded from technological evolution. Therefore, it is imperative that they benefit from such technologies, promoting their digital inclusion (Monteiro and Gomes 2009), communication and autonomy (de Sá et al. 2007).

So essential is the role of technology in our lives today that it is necessary that students develop critical skills to be prepared for the future. Nowadays, schools have the objective of developing digital citizenship and preparing the youth to face the increasingly complex challenges in our easily mutable society. ICT is a broad concept that, in an educational context, according to UNESCO (2011), includes mainstream technologies, assistive technologies, media and accessible formats, educational software and virtual learning environments.

In fact, it is essential that schools provide the necessary technology to visually impaired students (Abner and Lahm 2002), but more importantly, that they know what to do with it. Simultaneously with mainstream technology, a wide range of special devices and software—assistive technology—allows them to access information and the general curriculum. According to Presley and D'Andrea "once they have learned to use assistive technology to access electronic information, students with visual impairments can participate more equally with their sighted classmates" (2008, p.7).

To reach the real potential of ICT in these students education process, it is essential that educators use it in learning situations (Alves et al. 2009; Presley and D'Andrea 2008). Thus, new technological skills in this area are required for teachers of visually impaired students so it can enable them to properly apply technology in order to achieve important educational goals. As a result, "new competencies are required by teachers of pupils with visual impairments in mainstream schools", differing these "from the traditional model of training dating from the time of the special school and the 'sight class' era" (Söderberg and Fellenius 2000, p. 69). Considering the existence of barriers for visually impaired students learning, all teachers are prominent elements in their educational process, thus having a major role so that they are able to overcome their difficulties and achieve academic success.

In this context, this study focuses on teachers' opinions, who taught visually impaired students of middle school and secondary school in the 2012/13 school year, in the Portuguese reference schools. As proposed by Hill and Hill (2009), this investigation began with a preliminary study in which interviews with specialized teachers in the area of visual impairment were conducted. The information collected was used for planning the survey in order to be used in the main investigation. The study was introduced to all Portuguese reference schools for the education of blind and partially sighted students and, through the school boards, the web link to the survey was distributed to teachers of these students. The intent of this study is to analyze the perceptions of teachers on their knowledge, pedagogical practices and training in ICT, as well as the implementation and use of ICT in these specialized schools.

This paper is divided into seven sections. Section 2 focuses on the area of the study, ICT in the education of students who are blind or partially sighted and Section 3 on the characterization of the study is explored. The methodological framework of the study, taking into consideration the objectives of the study, is presented in Section 4. In Section 5 the results of the study are explored and the main conclusions are presented in Section 6. In Section 7 there's a brief discussion of future work.

2 ICT and the education of students who are blind or partially sighted

In the last decades, Portuguese governments have made a considerable effort to educate children with disabilities in regular public schools, including visually impaired students, providing a "school for all".

In Portugal, through the publication of the Decree-Law No. 3/2008, 7th January, a new organization for Special Education was outlined and a network of schools for the inclusion of students with visual impairment was created and regulated—the reference schools for the education of blind and partially sighted students. These are regular public schools, in which these students attend the same classes and have the same teachers as their sighted classmates. An important fact is that the inclusion of students with visual disability in the regular classes provides benefits for their social and academic level (Castellano 2005). This regulation intended to promote the inclusion of the visually impaired students in regular classes, providing the necessary specialized staff and educational and technological equipment for the learning process of these students with special education needs (DGIDC 2009). According to Decree-Law No. 3/2008, 7th January, this technological equipment includes: computers equipped with screen readers with Portuguese voice and refreshable braille displays; braille embossers; scanners; heat fusing machines; cubarithms; electronic calculators; electronic pocket magnifiers; Closed Circuit Television systems (CCTV); text to braille translation software; appropriate recording devices and digital media to access the Internet.

Noteworthy that in the 2012/2013 school year, approximately 225 students with visual disability attended the 41 Portuguese reference schools for the education of blind and partially sighted students. They have regular education teachers (non-specialists) and a special education teacher, with a specialization in the area of visual impairment who is the one that guides and works with these students and has the task of sharing information with the regular education teachers. This collaboration between regular and specialized teachers is very important for the constant exchange of knowledge for the benefit of the education of these students. According to Presley and D'Andrea, specialist teachers may share "information with regular education teachers about the value of assistive technology and how it promotes independence and ease of access to the school curriculum for students who are visually impaired" (2008, p. 20). The ICT will be part of the student's success if the entire educational team helps to promote its correct use in the educational context.

ICT plays a vital role in providing quality education for students with visual impairment by supporting new learning experiences (UNESCO 2006), improving the effectiveness of the teaching and learning process (Fuglerud 2011) and opening up a range of opportunities for these pupils (Junior and Coutinho 2009). In this sense, the opportunity to access ICT must be accessible to all, regardless of the capabilities of

each person (Monteiro and Gomes 2009). However, in the educational context, the means are not always available or suited to the real needs of students with or without special education needs (Ribeiro et al. 2010).

One aspect to consider in the use of ICT for visually impaired individuals is that they tend to minimize the deprivation of perceiving images, gestures and colours. The use of computers with speech synthesizers or even screen magnifiers provides them greater independence in the access and production of digital information. According to de Sá et al. (2007), the technologies expand the possibilities of communication and personal autonomy, minimizing or compensating for the constraints arising from lack of vision. The same authors defend that data processing stimulates cognitive development, enhances and leverages the appropriation of ideas, knowledge, skills and information.

According to Jackson (2012), the use of a screen reader for reading with audio support allows an improvement of the speed on information processing by students. Thus, it allows a better understanding of the text meaning, shortening the time required to complete the academic tasks. Pertinent results were also found for increases in the students' silent reading speeds and comprehension rates with the use of optical devices (Corn et al. 2002).

Many studies emphasize the potential of using ICT in education of individuals with visual impairments (BECTA 2000; Bickford and Falco 2012; Coelho et al. 2011; Gerber 2003; Jackson 2012; Kelly and Smith 2011; Papadopoulos and Goudiras 2005; Pattillo et al. 2004; Zhou et al. 2012), however, the existence of barriers is referenced on its use by them, noting the lack of accessibility of a large number of web pages and teaching resources, as well as students poor practice on using ICT, leading to a feeling of frustration when not being able to use it.

Despite all, "the use of ICT in education and training has been a priority in most European countries […] but progress has been uneven" (Balanskat et al. 2006, p. 2). The visual disability is perhaps one of the most underestimated area at the intersection of ICT and special education needs (Teles 2011). However, the practice of such technologies enables visually impaired students to better adjust to traditional learning processes, being allowed through these to access sources of information as their peers (Alves et al. 2009).

By keeping an open mind, becoming comfortable about technology and its pervasive role in our lives, encouraging students to explore and use technology to the fullest extent possible, and promoting skills through opportunities for practice, professionals working with students who are visually impaired can help them to excel in today's competitive world—and tomorrow's as well (Presley and D'Andrea 2008, p. 16).

The actual challenge is to provide appropriate access and assistance for the visually impaired students using ICT, making the best use of these throughout their schooling. Holmes et al. (2008) consider that teachers of visually impaired students need to understand and implement the use of the latest assistive technology. Despite the almost non-existent research conducted in Portugal in the field of visual impairment, international studies indicate that teachers of visually impaired students do not have enough training on technologies that are relevant to this area (Abner and Lahm 2002; Kapperman et al. 2002; Smith and Kelley 2007; Zhou et al. 2011). This lack of specific training is "more severe for teachers in the regular classroom" (Papadopoulos and

Goudiras 2005, p. 75), than for special education teachers. According to Smith and Kelley (2007) the use of ICT by students depends on teachers initial and continuous training acquired, however the deficit of teacher training is often cited as the leading barrier to the implementation of ICT in educational practices (Ribeiro et al. 2010). Despite the obvious weaknesses of teacher training, studies indicate that they believe in the potential of ICT as promoters of inclusive education (Alves et al. 2009; Benigno et al. 2007).

It should be noted that technologies by themselves do not mediate learning but just provide influence on learning strategies (Pires 2009). In this sense, ICT cannot be believed as the solution to all learning problems, but "should be considered as a support to the learning process" (Söderberg and Fellenius 2000, p.70).

As a consequence of ICT implementation in schools, particularly in the reference schools for the education of blind and partially sighted students, all teachers are required to expand their skills so that their activities can benefit from the educational technology resources.

3 The study

Based on the essential objectives of this study and on the UNESCO (2011) report, it was considered through this investigation that ICT in the educational context include mainstream technologies, assistive technologies, media and accessible formats, educational software and virtual learning environments.

This study is descriptive and analytical, focusing on the reality of Portuguese reference schools for the education of blind and partially sighted students in the 2012/2013 school year. Despite the fact that regular education teachers are non-specialists in the field of visual impairment, they must have sufficient knowledge in order to provide visually impaired students with an effective school education through participation in all activities as their sighted peers (Gasparetto 2001). In fact, it is important to assess the perceptions of all teachers involved in the educational process of students with visual impairments (Alves et al. 2009; Zhou et al. 2011). In this context, this study intends to analyse the perceptions of teachers who taught visually impaired students in the 2012/2013 school year in middle school and secondary school education, in Portuguese reference schools for the education of blind and partially sighted students, of their knowledge, teaching and training in the area of ICT, as well as the use of ICT by these learners.

Noteworthy that in the 2012/2013 school year approximately 225 visual impaired students attended the 41 Portuguese reference schools for the education of blind and partially sighted students (Table 1). The study had the collaboration of 21 (51 %) of these reference schools. The number of students with visual disability who attended this network of reference schools is quite unequal, depending on the geographical location of schools, which are aggregated by Regional Directorates of Education.

Taking into account the objectives of this study, it combined procedures based on quantitative and qualitative approaches. According to Goldenberg (2004), the set of different views and different ways of collecting and analysing data allows a wider and intelligible idea of the complexity of a problem.

Table 1 Distribution of students by Portuguese reference schools for the education of blind and partially sighted students, according to Regional Directorates of Education

Regional Directorates for Education	No. Portuguese reference schools	No. blind and partially sighted students on Portuguese reference schools	No. Portuguese reference schools involved in the study	No. blind and partially sighted students on Portuguese reference schools involved in the study
North Regional Directorate for Education	11	85[a]	7	63[b]
Centre Regional Directorate for Education	9	20	6	16
Lisbon and Tagus Valley Regional Directorate for Education	17	119	7	–[c]
Alentejo Regional Directorate for Education	4	1	1	1
Total	41	225	21	80

[a] This value does not include the number of visually impaired students from two reference schools due to non-cooperation of these on providing the requested data

[b] This value does not include the number of visually impaired students from one reference school due to non-cooperation of this on providing the requested data

[c] Lisbon and Tagus Valley Regional Directorate for Education only provided the total number of visually impaired students who attended the reference schools

4 Methodological framework and analysis

By contacting the four Regional Directorates for Education as well as the school board of the reference schools, a documentary collection was conducted on the state of these schools. In order to prepare an appropriate instrument to investigate, that is, a valid and reliable survey to be applied to teachers of visually impaired students attending the reference schools for the education of blind and partially sighted students, in the 2012/2013 school year, a preliminary study was conducted.

One of the main goals of the preliminary study was to find the important variables to include in the main study (Hill and Hill 2009). Four teachers, specialists in the area of visual impairment and belonging to different schools and contexts, were interviewed. As mentioned above, these professionals have a specialization in the area of visual impairment and provide educational support to children and young people with blindness or low vision. According to Bogdan and Biklen, both cited by Sonza (2008), the quality research emphasizes the description, induction and grounded theory as well as the study of personal perceptions. This way, the information gathered through the interviews was analysed to find common themes and issues that outline the most important aspects to consider in the main study.

As proposed by Hill and Hill (2009), after the preliminary study, all the information collected was used to design the survey which is one of the most adopted techniques to collect data (Gillham 2000). The survey was based on the study by Jacinta Paiva (2002), in which the author intended to measure the use of ICT by teachers. After

developing the survey, there was a validation by two experts in the area of visual impairment and by the Education Planning and Statistics Office (GEPE), a central service of the Ministry of Education. In order to be applied on the 41 Portuguese reference schools for the education of blind and partially sighted students, the survey had the approval of GEPE.

A web based survey was created using LimeSurvey software and had restricted access through the use of a password. The sample consisted of 42 teachers, spread over 21 reference schools. The study had the collaboration of about 51 % of the reference schools for the education of blind and partially sighted students. The survey contained five groups:

Group I – Personal characteristics;
Group II – Computer proficiency and pedagogical teaching;
Group III – Continuous training;
Group IV – ICT use in curriculum context;
Group V – Perceptions.

The first group of the survey was intended to be an overview of the personal characteristics of the sample. Regarding computer proficiency and pedagogical teaching (Group II) it raises questions about the use of mainstream technology and technology designed specifically for visually impaired people. Teachers are also asked about the importance of the use of ICT in teaching and learning of visual impaired students. Group III was intended to assess the ICT training of the sample, as well as in what areas they consider in need of more training. Concerning to ICT use in curriculum context (Group IV), it was intended to make a comparison between the degree and forms of ICT use by these teachers with their sighted and visually impaired students. In this sense, it was relevant to establish what ICT was used in classroom context by their blind and partially sighted students. Group V is related to the samples' perceptions on the inclusion of visually impaired students in regular classes, as well as on general aspects related to ICT.

The survey has open and closed questions, being this strategy useful for applying qualitative information to complement and contextualise the quantitative information achieved by the other variables (Hill and Hill 2009). Considering that the sample includes non-specialists teachers and others with a specialization in the area of visual impairment, in some questions, the data was analysed in two separate groups: regular education teachers and special education teachers.

The data was collected between March and May 2013 and all the statistics were conducted using Statistical Package for the Social Sciences (SPSS), version 20.

5 Results

From 21 (51 %) of the 41 Portuguese reference schools for the education of blind and partially sighted students, 42 teachers completed the survey. Of the 42 participants, 20 (48 %) are specialist teachers in the area of visual impairment and 22 (52 %) are regular education teachers. All of them have significant experience in educational context, yet with fewer years of teaching students with visual disability (23 % of participants had

been teaching blind or partially sighted students for the first time in the 2012/2013 school year).

Most teachers are proficient in computer use (98 %). This tool is widely used by the sample in educational activities, particularly developing evaluation forms (90 %) and presentations (68 %), searching on the Internet (83 %) and working with software (83 %). Moreover, with the exception of specialist teachers, the degree of knowledge of specific tools used by visually impaired students is low. Regular education teachers mostly have none or a very poor knowledge of all the tools presented, with exception of the electronic pocket magnifier, scanner and digital recording device (Table 2). Concerning special education teachers, their knowledge is more pronounced, however, they had gaps in the tools with more technical and demanding details, such as the Closed Circuit Television (CCTV), the heat fusing machine, the electronic braille note-taker and the refreshable braille display (Table 2).

Regarding specific computer software in the area of visual impairment, the gap between levels of knowledge among teachers is evident (Table 3). Regular education teachers have a great lack of knowledge in presented computer software with the exception of Windows accessibility options (55 % of teachers expressed a degree of knowledge above moderate).

In software widely used by individuals with visual impairment, such as ZoomText and Winbraille, 5 % of special education teachers have no knowledge. Overall, the sample has more knowledge about specific tools used by visually impaired students

Table 2 Teachers knowledge about specific tools used by visually impaired students, divided into regular education teachers and special education teachers (n=22 / n=20)

Regular education teachers							Special education teachers					
None	Very low	Low	Moderate	Good	Very good		None	Very low	Low	Moderate	Good	Very good
23 %	0 %	9 %	41 %	18 %	9 %	Electronic pocket magnifier	0 %	0 %	0 %	20 %	35 %	45 %
32 %	18 %	5 %	23 %	9 %	14 %	CCTV	0 %	0 %	5 %	10 %	40 %	45 %
23 %	14 %	27 %	14 %	9 %	14 %	Braille embosser	0 %	0 %	0 %	15 %	40 %	45 %
45 %	14 %	9 %	9 %	9 %	14 %	Heat fusing machine	0 %	5 %	10 %	25 %	35 %	25 %
41 %	14 %	23 %	14 %	5 %	5 %	Refreshable braille display	0 %	5 %	15 %	65 %	10 %	5 %
5 %	9 %	5 %	23 %	32 %	27 %	Scanner	0 %	0 %	5 %	10 %	40 %	45 %
9 %	5 %	5 %	18 %	27 %	36 %	Digital recording device	0 %	0 %	5 %	15 %	50 %	30 %
45 %	0 %	23 %	14 %	18 %	0 %	Electronic braille note-taker	5 %	5 %	25 %	30 %	35 %	0 %
86 %	0 %	0 %	0 %	5 %	9 %	Other(s)	65 %	0 %	0 %	15 %	10 %	10 %

Table 3 Teachers knowledge about specific software for visually impaired students, divided into regular education teachers and special education teachers (n=22 / n=20)

Regular education teachers							Special education teachers					
None	Very low	Low	Moderate	Good	Very good		None	Very low	Low	Moderate	Good	Very good
59 %	5 %	5 %	23 %	5 %	5 %	Zoom Text	5 %	10 %	20 %	15 %	25 %	25 %
73 %	9 %	9 %	5 %	5 %	0 %	Magic	20 %	10 %	25 %	15 %	20 %	10 %
45 %	23 %	5 %	14 %	9 %	5 %	Jaws	0 %	0 %	5 %	35 %	40 %	20 %
82 %	0 %	0 %	9 %	9 %	0 %	Window Eyes	15 %	5 %	20 %	40 %	10 %	10 %
55 %	5 %	14 %	14 %	14 %	0 %	NVDA	0 %	10 %	15 %	35 %	30 %	10 %
68 %	9 %	14 %	0 %	9 %	0 %	Dosvox	10 %	15 %	25 %	35 %	15 %	0 %
36 %	9 %	5 %	32 %	9 %	9 %	Windows Accessibility Options	0 %	5 %	5 %	25 %	45 %	20 %
59 %	0 %	18 %	14 %	5 %	5 %	Winbraille	5 %	0 %	20 %	30 %	15 %	30 %
59 %	5 %	9 %	14 %	5 %	9 %	Braille Fácil	0 %	0 %	0 %	30 %	45 %	25 %
68 %	5 %	9 %	5 %	9 %	5 %	ABBYY FineReader	20 %	15 %	15 %	10 %	20 %	20 %
77 %	0 %	5 %	14 %	5 %	0 %	OPENBook	35 %	15 %	25 %	10 %	5 %	10 %
95 %	0 %	0 %	0 %	0 %	5 %	Other(s)	70 %	0 %	5 %	15 %	5 %	5 %

than about specific software. This unawareness can only be changed with additional technology training.

Contrasting with presented data in Tables 2 and 3, a significant proportion (73 %) of regular education teachers and of special education teachers (85 %) have confidence in their technological capabilities to help students with visual disability to achieve the best possible results with the use of ICT. Regarding the on-going training, 93 % of the sample attended training in ICT (Table 4); however this percentage is lower when it comes to technology designed for students with visual impairment (64 %). It is important to refer that 29 % of the sample has training in ICT but none of this is in technology designed for students with visual disability.

This sample pursues a constant update in technology, but not in technology designed for blind or partially sighted students. They consider that there is a limited offer of training in this particular area, which may explain the diminished training by these teachers. Nevertheless, teachers who have training in technologies designed for students with visual impairment mention its positive effects (93 %) with these learners.

A relevant finding is that only 19 % of these teachers claim to have had training on ICT adapted for visual impairment in their initial academic training. This fact emphasizes the vacuity with regard to this subject in the undergraduate curriculum component of the educational area.

Despite the lack of training on ICT designed for students with visual impairment, 91 % of the participants believe that for the efficient use of these it is necessary that teachers receive training in this specific area. They are receptive to learn more about this subject and motivated to apply it with their students, nevertheless they consider that

Table 4 Training, in hours, on ICT and technology designed for students with visual impairment (n=42)

% of total		Training in ICT						
		None	<25 h	25–50 h	51–75 h	76–100 h	>100 h	Total
Training in technology designed for students with visual impairment	None	7 %		7 %	7 %	5 %	10 %	36 %
	<25 h		5 %	5 %	5 %		7 %	21 %
	25–50 h			10 %	7 %	5 %	5 %	26 %
	51–75 h				2 %	2 %	2 %	7 %
	76–100 h						2 %	2 %
	>100 h						7 %	7 %
	Total	7 %	5 %	21 %	21 %	12 %	33 %	100 %

there should be a wider offer of training on ICT adapted to the visually impaired (62 %). Important to note that 98 % of the participants state the necessity of having more training and 21 % of the sample emphasize their unawareness of everything related to technologies designed specifically for students with visual impairment.

Most teachers (98 %) underline the importance of ICT implementation in the educational context with blind and partially sighted students and refer its positive impact on the process of acquiring knowledge (95 %) and communication between teachers and visually impaired students (69 %). In addition, they consider that its use speeds up reading/writing (71 %) and promotes independence (95 %) and inclusion (79 %) of these students in the educational system.

Analysing the perceptions of teachers about computer usage in an educational context, the gathering of data indicates that the use of this tool is further reduced with students who are blind or partially sighted than with sighted students (Chart 1). Teachers who teach these two groups of students (n=36) considered that they do not increase its use with their visually impaired students due to the specific characteristics of the subjects they teach (70 %) but also for lack of knowledge (30 %) and time to meet the objectives of the program (20 %).

Of the 21 reference schools for the education of blind and partially sighted students, 19 have a Moodle platform. Despite approximately 90 % of schools having the platform, it is rarely (17 %) or never (55 %) used by most teachers with their visually impaired students. Aware that the reasons for the low degree of Moodle platform use in one school may not be the same as those in another, these teachers (72 %) report the specifics of the subjects taught (37 %), the lack of teacher's preparation (27 %) and accessibility issues because visually impaired students do not know how to use it (27 %). Noteworthy that teachers of both groups of students (n=36) claim more usage of this tool with their sighted students than with the visually impaired.

Regarding accessibility issues presented by teachers as justification for Moodle platform reduced use with their visually impaired students, the gap in teachers training concerning the creation of accessible materials is also an obstacle to the low use of the platform by these students. It is important to notice that the Moodle platform meets the accessibility requirements set by the standards of the World Wide Web Consortium (W3C) in all its versions, and only needs some teachers caution in preparing their subject on the platform (Coelho et al. 2011).

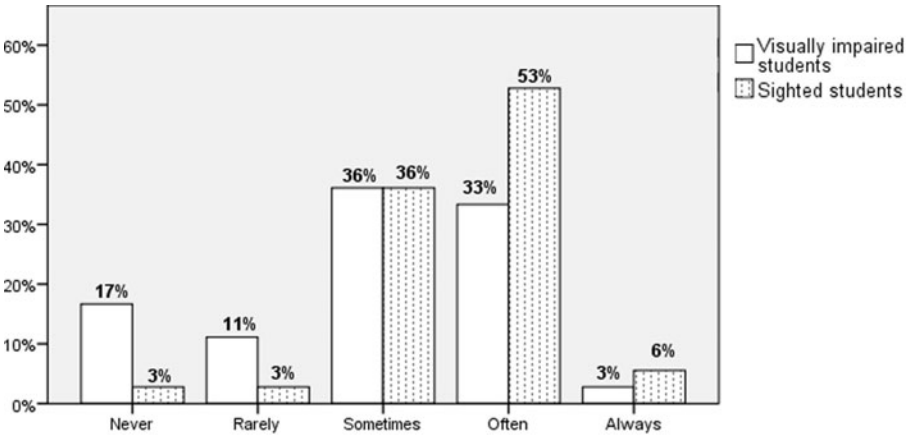

Chart 1 Degree of computer use in direct interaction with sighted and visually impaired students during classes (n=36)

This study was conducted with teachers who taught in Portuguese reference schools for the education of blind and partially sighted students, with a legal framework that ensures the concentration of human and material resources that can offer an educational response with quality to these students with special education needs. In this sense, teachers shared their perceptions about ICT use by their blind and partially sighted students, in the educational context (Tables 5 and 6).

Specific tools and software designed for visually impaired students, according to the sample, are not widely used in their classrooms by these learners. The data presented in Tables 5 and 6 provide evidence that these technologies are mainly used in regular education teachers' classroom than in the specialist education teachers. Some tools are less used, such as the refreshable braille display and the electronic braille note-taker, being these two among the tools that teachers had less knowledge of, as stated in Table 2. With the exception of screen reader Jaws and Windows accessibility options, the percentages of non-use or rare usage of presented software are equal to or greater than 50 % (of the total sample).

The production and publication of information (79 %) as well as the research for information on the Internet (62 %) are the activities most used by these teachers with their visually impaired students. They consider themselves having reasonable knowledge about educational resources and report the lack of pedagogical software (67 %), educational digital games (57 %) and digital books (38 %) to implement in their educational activities with their visually impaired learners. It is important to point out that special education teachers develop more activities using the computer with these students than regular education teachers.

Regarding the integration of ICT in the visually impaired students' education, teachers indicated the lack of specific training in this area as the most difficult obstacle to overcome, followed by the lack of specific software and digitally adapted resources for these students. They consider the lack of technical means as the third most difficult obstacle to overcome followed by the lack of human resources, such as a computer technology advisor to help teachers, and last the lack of teacher's motivation.

Table 5 Specific ICT tools used by visually impaired students during their lessons with regular education teachers and special education teachers (n=22 / n=20)

Regular education teachers							Special education teachers					
Never	Rarely	Sometimes	Often	Always	No opinion		Never	Rarely	Sometimes	Often	Always	No opinion
36 %	5 %	14 %	18 %	23 %	5 %	Electronic pocket magnifier	20 %	15 %	15 %	30 %	15 %	5 %
55 %	9 %	0 %	9 %	18 %	9 %	CCTV	20 %	10 %	5 %	30 %	30 %	5 %
55 %	5 %	5 %	23 %	5 %	9 %	Braille embosser	20 %	10 %	50 %	5 %	10 %	5 %
64 %	5 %	9 %	9 %	5 %	9 %	Heat fusing machine	25 %	10 %	45 %	10 %	5 %	5 %
68 %	5 %	9 %	5 %	9 %	5 %	Refreshable braille display	65 %	5 %	10 %	5 %	10 %	5 %
55 %	9 %	9 %	9 %	5 %	14 %	Scanner	35 %	15 %	15 %	20 %	10 %	5 %
55 %	14 %	18 %	9 %	0 %	5 %	Digital recording device	15 %	35 %	30 %	10 %	5 %	5 %
50 %	0 %	5 %	23 %	18 %	5 %	Electronic braille note-taker	55 %	5 %	20 %	10 %	5 %	5 %
73 %	0 %	0 %	14 %	0 %	14 %	Other(s)	50 %	0 %	5 %	5 %	10 %	30 %

Table 6 Specific software used by visually impaired students during their lessons with regular education teachers and special education teachers (n=22 / n=20)

Regular education teachers							Special education teachers					
Never	Rarely	Sometimes	Often	Always	No opinion		Never	Rarely	Sometimes	Often	Always	No opinion
59 %	5 %	5 %	14 %	0 %	18 %	Zoom Text	35 %	10 %	15 %	10 %	20 %	10 %
73 %	5 %	0 %	5 %	0 %	18 %	Magic	50 %	10 %	15 %	10 %	0 %	15 %
55 %	0 %	0 %	23 %	5 %	18 %	Jaws	30 %	5 %	10 %	20 %	30 %	5 %
68 %	0 %	5 %	9 %	0 %	18 %	Window Eyes	55 %	25 %	15 %	0 %	0 %	5 %
55 %	5 %	5 %	14 %	0 %	23 %	NVDA	25 %	15 %	20 %	30 %	5 %	5 %
59 %	9 %	9 %	0 %	0 %	23 %	Dosvox	75 %	10 %	10 %	0 %	0 %	5 %
55 %	0 %	14 %	18 %	5 %	9 %	Windows Accessibility Options	5 %	5 %	35 %	45 %	5 %	5 %
64 %	5 %	5 %	5 %	5 %	18 %	Winbraille	40 %	5 %	25 %	15 %	10 %	5 %
59 %	0 %	0 %	18 %	5 %	18 %	Braille Fácil	30 %	10 %	20 %	20 %	15 %	5 %
55 %	5 %	5 %	14 %	0 %	23 %	ABBYY FineReader	50 %	20 %	15 %	5 %	5 %	5 %
68 %	5 %	0 %	5 %	0 %	23 %	OPENBook	70 %	15 %	0 %	10 %	0 %	5 %
73 %	0 %	0 %	5 %	0 %	23 %	Other(s)	70 %	0 %	0 %	5 %	0 %	25 %

Nevertheless, participants demonstrate a very positive attitude towards ICT and their perceptions on the implementation of these with visually impaired students indicate that ICT promote the transmission of knowledge in the teaching and learning process (95 %). They also consider that ICT motivate these students with special education needs (93 %), contributing to academic success (76 %) and promoting their inclusion in the educational system (79 %).

6 Conclusion

Although this study has supported that ICT are daily tools of the interviewed teachers, they still express little resourcefulness and knowledge in most of the tools and applications designed for students who are blind or partially sighted. This is reflected in lower utilization of ICT in the classroom context with visually impaired students than with sighted students by these teachers. However, the sample considers that ICT promote the transmission of knowledge and improve the teaching and learning process, contributing to academic success, autonomy and inclusion of students who are blind or partially sighted.

This sample of teachers believes mostly in the inclusion of visually impaired students in regular schools but teachers' knowledge does not seem to be enough to promote digital inclusion of these students. A significant number of teachers have ICT training; however, this number significantly decreases when referred to specific ICT for visual impairment. Therefore, they feel more familiar with general technology than with technology designed specifically for students with visual impairment. The sample considers that there exists a limited training offer in this specific area, which may explain the lack of knowledge by these participants.

Thus, the scant teachers' training is one of the major obstacles for the effective integration of ICT in blind and partially sighted students' educational context and the consequent implementation of any educational and technological change. Nevertheless, the sample expresses interest to improve their knowledge in technologies designed for visually impaired students. Their needs in ICT training are more pronounced in regular education teachers than in special education teachers.

The current results are consistent with previous studies reported in literature and conducted in other countries. Thereby, considering that there is a long way to go, the success of using ICT for educational purposes with blind and partially sighted students depends on the material conditions of the schools and the efforts made by the educational community, specifically by the teachers, to implement these technologies in the learning process.

7 Future work

In this network of reference schools, according to the Decree-Law No. 3/2008, 7th January, are concentrated the human and material resources that can offer an educational response with quality to blind and partially sighted students. Thereby, it is important to analyse the technological context in which these students are educated. Since this study was limited to 21 Portuguese reference schools for the education of

blind and partially sighted students, the study needs to be conducted in all reference schools, with all teachers, for more detailed information.

Furthermore, an in-depth study should be made centred on the available resources in these reference schools and on the use of ICT in the educational context by students with visual impairment. The perceptions of these students about technologies use should be examined. Therefore, to a thorough study on the use of braille technologies, further research should be done on the prevalence of braille use among blind students.

Glossary

ABBYY FineReader	Reading/scanning software that enables conversion of text images, received from scanner, into e-text that can be editable.
Braille embosser	Hardware that transfers computer-generated text into embossed braille.
Braille Fácil	Text-to-braille translation software.
CCTV	Closed Circuit Television – Electronic magnification reading system, which makes use of electronics and video cameras to produce a magnified image of a variety of materials and writing.
Cubarithm	Tool to teach the layout of arithmetic problems. It consists of a work board divided into square compartments into which cubes that are embossed with braille characters may be placed.
Dosvox	Operating system that contains the elements of the user interface; speech synthesis system; editor, reader and printer text files; educational and playfulness games; screen reader and screen magnifier.
Electronic braille note-taker	Portable device with braille keyboard used to input, store and output text either in braille or print. A speech synthesizer or braille display is used for output.
Electronic pocket magnifier	Portable magnification device designed to fit in the palm of a hand.
Heat fusing machine	Hardware that makes flat print images tactually accessible.
Jaws	Screen reader software.
Magic	Magnifying software.
NVDA	Screen reader software.
OPENBook	Reading/scanning software that enables conversion of text images, received from scanner, into e-text that can be edited.
Refreshable braille display	Tactile device with pins controlled electronically, which pop up and down to show up to one computer line at a time in braille. As the pins move up and down, they form a refreshable braille line that can be read by touch.
Screen magnifier	Software that magnify a section of a computer screen.
Screen reader	Software that uses synthesized speech to convert electronic graphics and text represented in computer screen into an audio format.

Speech synthesizer	Computer system used for simulation of human speech.
Text to braille translation software	Software that translate print to braille.
Winbraille	Text-to-braille translation software.
Window Eyes	Screen reader software.
ZoomText	Magnifying software.

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