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# The influence of assistive technology devices on the performance of activities by visually impaired

## *A influência de recursos de tecnologia assistiva sobre a performance em atividades de deficientes visuais*

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### *ABSTRACT*

***Objective**: To establish the influence of assistive technology devices (ATDs) on the performance of activities by visually impaired schoolchildren in the resource room. **Methods**: A qualitative study that comprised observation and an educational intervention in the resource room. The study population comprised six visually impaired schoolchildren aged 12 to 14 years old. The participants were subjected to an eye examination, prescribed ATDs comprising optical and non-optical devices, and provided an orientation on the use of computers. The participants were assessed based on eye/object distance, font size, and time to read a computer screen and printed text. **Results**: The ophthalmological conditions included corneal opacity, retinochoroiditis, retinopathy of prematurity, aniridia, and congenital cataracts. Far visual acuity varied from 20/200 to 20/800 and near visual acuity from 0.8 to 6 M. Telescopes, spherical lenses, and support magnifying glasses were prescribed. Three out of five participants with low vision after intervention could decrease the font size on the screen computer, and most participants (83.3%) reduced their reading time at the second observation session. Relative to the printed text, all the participants with low vision were able to read text written in smaller font sizes and reduced their reading time at the second observation session. **Conclusion**: Reading skills improved after the use of ATDs, which allowed the participants to perform their school tasks equally to their classmates.*


***Keywords**: Vision disorders;Visual acuity; Vision, low;Assistive technologies;Visually impaired persons*

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## Resumo

**Objetivo**: Verificar a influência da utilização de recursos de tecnologia assistiva no desempenho de escolares com deficiência visual em atividades em sala de recursos. **Métodos**: Realizou-se pesquisa qualitativa, por meio de observação e intervenção educacional em sala de recursos. A população foi composta por seis escolares com deficiência visual situados na faixa etária entre 12 e 14 anos. Os escolares fizeram exame oftalmológico e receberam prescrição de recursos de tecnologia assistiva distribuídos em recursos ópticos, não-ópticos e orientação para uso da informática. Foram observados quanto à distância olho-objeto, tamanho de fonte e tempo de leitura. **Resultados**: Diagnósticos oftalmológicos: opacidade corneana, retinocoroidite, retinopatia da prematuridade, aniridia e catarata congênita. A acuidade visual para longe variou de 20/200 a 20/800 e para perto de 0,8 M a 6 M. Foram prescritos telescópios, lentes esféricas e lupas de apoio. Comparando-se o tamanho de fonte utilizado no computador verificou-se que na segunda observação, três dos cinco escolares com baixa visão leram fontes menores no computador e a maioria (83,3%) melhorou o tempo de leitura na segunda observação. Em relação ao tamanho de fonte e tempo utilizado para lerem os textos impressos, todos os escolares com baixa visão conseguiram ver tipos menores e diminuíram o tempo de leitura na segunda observação. **Conclusão**: Constatou-se o melhor desempenho das habilidades de leitura, após o uso de recursos de tecnologia assistiva, o que facilitou a realização de atividades acadêmicas em igualdade aos colegas da sala.


**Descritores**: Distúrbios da visão; Acuidade visual; Baixa visão;Tecnologia assistiva; Pessoas com deficiência visual

## Introduction

According to the World Health Organization (WHO), the levels of disability associated with visual impairment range from low vision to blindness[1].

The 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) defines low or subnormal vision as a visual acuity of less than 0.3 and equal to or greater than 0.05 in the eye with the best corrected vision or a visual field of less than 20 degrees (categories 1 and 2 of vision impairment). Blindness is defined as a visual acuity of less than 0.05 or a visual field of less than 10 degrees (categories 3, 4, and 5 of vision impairment). An undetermined or unspecified loss of vision corresponds to category 9. This classification is based on the 9th revision of the ICD with the classification in the ICD-10 as a reference[2].

The following visual functions might be affected in individuals with low vision: visual acuity, visual field, an adaptation to light and dark, and color perception. The visual function of individuals with low vision might be improved with assistive technology devices (ATDs).

Assistive technology is an interdisciplinary field of studies that encompasses products, resources, methods, strategies, practices, and services to enhance the functional capability related with the activity and participation of people with deficiencies, disabilities, or reduced mobility to improve their autonomy, independence, quality of life, and social inclusion[3].

ATDs are potentially beneficial for schoolchildren with low vision and are classified as optical, non-optical, electronic, or computer-based. Computer-based resources for blind individuals include refreshable Braille displays and software replacing images with voice (voice synthesizers)[4,5].

Schoolchildren with low vision might exhibit difficulties in reading and writing even while using optical and non-optical aids. For such schoolchildren, computer-based devices might not only be helpful in school assignments but also as pedagogical instruments that facilitate the insertion of computers in social and educational practices, thus becoming relevant for the academic development of such children[6].

It is important to convey the benefits associated with ATDs among schoolteachers to improve visually impaired students' access to special education within the context of a partnership between the education and healthcare fields to provide global interventions for the visually impaired[7,8].

The aim of the present study was to investigate the influence of ATDs on the performance of school tasks by visually impaired schoolchildren as a function of the relevance of the educational conditions necessary for the development of individuals with low vision.

## Methods

The present qualitative study included observations of schoolchildren in their natural environment, and an educational intervention was performed in a resource room for the visually impaired.

The study population comprised six schoolchildren, five with low vision, and one blind, from 12 to 14 years old. The children attended a public elementary school in the municipality of Santa Barbara do Oeste, São Paulo state, Brazil and were users of the resource room for the visually impaired.

The participants were subjected to a full eye examination by eye doctors from the Subnormal Vision Service, Clinical Hospital of the School of Medical Sciences, State University of Campinas (Serviço de Visão Subnormal do Hospital das Clínicas da Faculdade de Ciências Médicas da Universidade Estadual de Campinas – SVSN/HC/FCM/UNICAMP). Optical and non-optical aids were prescribed to the participants on an individual basis.

The study was approved by the Research Ethics Committee of the School of Medical Sciences of the State University of Campinas under ruling no. 421/2003.

The participants and their guardians signed an informed consent form following an explanation of the study aims.

### Procedures

During the initial observation session in the natural environment setting, the participants performed school assignments in the resource room. For the tasks that involved reading on a computer screen and from a printed text, the researcher provided a simply written text (Text 1) and assessed the following:

1 – the eye-object distance relative to the computer screen, font size, and time required to read;

2 – the eye-object distance relative to the sheet of paper (printed text), font size, and time required to read.

### Text 1

"The boy and the man: When I was a child and it rained, our home became a leak festival. The ceiling dripped and soaked

the floor of all the rooms and halls. We'd all get crazy, running here and there with pails, bowls, pots, and potties"[9].

An educational intervention was then performed. This intervention consisted of a course on the use of accessibility software for the visually impaired taught by a teacher with computer specialization.

The 144-hour course was taught over eight months and comprised the simultaneous use of the accessibility assistant software included in the computer and sound or magnification software (Dosvox or Virtual Vision).

During the final session of observation assessing the participants' performance, reading and typing activities (Text 2) were performed using optical, non-optical, and computer-based devices. The text was selected based on the participants' academic level. The parameters assessed were identical to those utilized in the initial observation session:

1 – the eye-object distance relative to the computer screen, font size, and time required to read;

2 – the eye-object distance relative to the sheet of paper (printed text), font size, and time required to read.

**Text 2**

"What is love? Two teachers taught the fourth grade. One was young and inexperienced. The other was a woman in her sixties, and had an advantage of 40 years of brilliant performance reviews that made her be known as a good teacher"[10].

## Results

The data relative to the eye examination and device prescription are described in table 1.

The data collected during the observation sessions before and after intervention are comparatively described in tables 2 and 3.

Table 2 shows the reduction of the time required to type and read on the screen. For participants 2 and 5, the teacher chose to increase the font size at the second observation to improve their body posture and achieve better visual performance.

Table 3 shows that the reading time also decreased relative to the printed text. A comparison of tables 2 and 3 shows that the reading time on the computer screen was similar or longer than that corresponding to the printed text.

**Table 1**

**The cause of vision impairment, corrected visual acuity, and optical and additional devices prescribed to the visually impaired schoolchildren (SVSN/HC/FCM/UNICAMP)**

| Participants | Gender | Age | School grade | Diagnosis | Corrected visual acuity | Prescribed optical devices | Non- optical, Braille, and computer-based devices |
|---|---|---|---|---|---|---|---|
| 1 | F | 13 | 7th | Low vision because of bilateral corneal opacity | Far: 20/800 LE and RENear: 1.6 M LE and RE (approximately 15 cm) | Spherical lens+ 18.00D LE and 4X monocular telescope | Magnification software, typoscope, and reading material contrast |
| 2 | F | 12 | 7th | Low vision because of retinochoroiditis | Far: 20/300 RE and 20/ 600 LENear: 0.8 M RE and 6 M LE | 4X monocular telescope | Magnification software |
| 3 | M | 12 | 7th | Low vision because of retinopathy of prematurity | Far: 20/400 LE and RENear: 6 M LE and RE | 4X monocular telescope and 7X support magnifying glass | Magnification software |
| 4 | F | 14 | 9th | Low vision because of bilateral optic atrophy | Far: 20/200 LE and RENear: 1.2 M LE and RE | 2.8X monocular telescope and 2.5X ruler magnifying glass | Magnification software |
| 5 | F | 13 | 8th | Low vision because of bilateral aniridia and congenital cataract | Far: 20/200 LE and RENear: 2 M LE and RE (close to the eye) | 4X monocular telescope | Magnification software |
| 6 | F | 12 | 7th | Blindness because of retinopathy of prematurity | NLP | | Braille system and sound software |

## Discussion

The present study included an adaptation of the ATDs so reading and writing could be performed simultaneously. The optical and computer-based devices were mutually adjusted, thus resulting in shorter reading times. The adjustment of the prescribed optical and non-optical aids was relevant for the results observed.

The schoolchildren interviewed in a study conducted at State University of Campinas (Unicamp) reported that when optical,

**Table 2**

**Eye/object distance, font size, reading time on the computer screen during the first and second observation sessions**

| Participants | Observation | Eye/object distance | Font size/ Braille system | Reading time on the screen |
|---|---|---|---|---|
| 1 | 1st | 8 cm | 72 | 10’ |
| | 2nd | 7 cm | 60 | 08’ |
| 2 | 1st | 8 cm | 24 | 02’ |
| | 2nd | 12 cm | 35 | 02’ |
| 3 | 1st | 12 cm | 46 | 03’ |
| | 2nd | 11 cm | 42 | 02’ |
| 4 | 1st | 25 cm | 28 | 04’ |
| | 2nd | 30 cm | 26 | 02’ |
| 5 | 1st | 10 cm | 16 | 02’ |
| | 2nd | 11 cm | 22 | 37’’ |
| 6 | 1st | - | Braille | 15 |
| | 2nd | - | Braille | 08’ |

**Table 3**

**The eye/object distance, font size, and reading time relative to the printed text during the first and second observation sessions**

| Participants | Observation | Eye/object distance | Font size/ Braille system | Reading time on the screen |
|---|---|---|---|---|
| 1 | 1st | 05 cm | 46 | 10’ |
| | 2nd | 07 cm | 60 | 04’ |
| 2 | 1st | 10 cm | 24 | 07’ |
| | 2nd | 07 cm | 22 | 02’ |
| 3 | 1st | 05 cm | 28 | 03’ |
| | 2nd | 03 cm | 22 | 02’ |
| 4 | 1st | 25 cm | 28 | 03’ |
| | 2nd | 23 cm | 22 | 02’ |
| 5 | 1st | 08 cm | 16 | 02’ |
| | 2nd | 08 cm | 22 | 40’’ |
| 6 | 1st | - | Braille | 02’ |
| | 2nd | - | Braille | 02’ |

non-optical, and ATDs were deficient, the schools resourced the Braille machine and requested that schoolmates dictate the indicated texts. That situation can now be reversed[11].

Our results show improved reading speeds with the addition of magnification and/or sound software to the optical devices appropriate for each individual case. The use of such devices prevents the occurrence of visual fatigue in individuals with low vision[12].

Typing ability is assessed as using the keyboard without looking at the keys. The course taught to the participants in the present study allowed them to acquire full control of the keyboard, which is the main tool for the visually impaired to become independent in this domain[13].

The development of computer-based technology has been becoming increasingly faster, thus changing the patterns for learning and work. Eventually, use of this technology became a mandatory skill for the job market and in the academic setting, particularly in the case of the visually impaired[14].

Visually impaired individuals need to be acquainted with and use optical aids and devices and become acquainted with computers to improve their performance in the use of technologies that might contribute to their social and school inclusion[15].

The results of the present study are not restricted to the intended aim and include the effects of educational intervention because the participants learned how to use the computer, which contributes to the school knowledge and a consequent awareness of the needs of visually impaired schoolchildren and the necessary facilities for the use of associated assistive technology. From that perspective, the participants were introduced to the use of technologies that contributed to their acquisition of reading and writing skills that are useful for the performance of school tasks and their subsequent social insertion.

## Conclusion

The present study showed reading skill improvement following the use of ATDs, which resulted in increased efficiency, improving the performance of school tasks.

The use of ATDs in the education of visually impaired schoolchildren grants them access to pedagogical materials and helps them perform school tasks equally to their classmates, thus improving their performance and allowing them to overcome their handicap.

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