Eyes on Our World: Enhancing Literacy Skills for Students with Low Vision

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Students with low vision who participate in inclusive programs in primary, secondary, or tertiary education can use optical devices for near and short-term distant tasks. Sustained use of these devices, however, can be physically difficult and tiring, especially for reading all the information on blackboards or whiteboards or displayed around the room. In many inclusive settings, a teacher aide or student peer supports these students by sitting beside them and copying, reading, or describing information. Although beneficial, this support can cause embarrassment and facilitate dependence. This paper describes development of a system that enables students with vision impairments to view easily text, people, or objects in a classroom. Software was designed for a personal computer, rotating web camera, and a joystick or mouse. Students at a desk can scan, zoom and focus on near or far information within a 7 metre radius. As writing and reading areas are accessed simultaneously through a split screen, students can record notes or complete written tasks while viewing text or images. They can interact immediately as the text or image is added and be less isolated from regular class activities. This technology has potential for the enhancement of literacy, social interaction and independence.

Introduction

Many students with low vision participate in inclusive education programs in regular primary, secondary, or tertiary education settings with their teachers and peers. About 60% of children who are visually impaired (that is, are blind or have low vision) attend mainstream schools in the United Kingdom (Clunies-Ross & Keil, 1999). American figures suggest a considerably higher percentage with 90% of the visually impaired student population believed to be educated in public schools (Corn, Bina, & DePriest, 1995). In Australia, the majority of children with visual impairments and no other disability attend their local school, usually with some support from a visiting teacher service (Palmer, 2000). Inclusive education has been described in terms of a consistent effort to consider the special needs and differences of individual learners when planning and managing their education in mainstream programs (Brickell, 2003; Dimigen, Roy, Horn, & Swan, 2001; Tomlinson, 1996).

Visually impaired students are known to face a wide range of complex academic and social challenges when working within mainstream educational settings (Dimigen, Roy, Horn, & Swan, 2001). Effective communication with teachers and peers is central to many of their challenges. Teachers and students communicate with each other through a range of oral, written and non-verbal expressive behaviours. Students with low vision are often not privy to some of these communicative practices as a result of their disabilities. Information passed on by teachers or peers can be misconstrued, or meanings not accessed immediately. In order to assist independent working habits in classrooms, visually impaired learners may be given a range of low vision aids and technological tools such as magnifiers, monoculars and closed circuit television (CCTV). In addition, "computers have become important tools for people with low vision to use in gaining access to information" (Corn & Koenig, 2002, p. 306). There are, however, reports of low acceptance of low vision aids in school classrooms, especially as students approach adolescence, (Fellenius, 1996; Mason, 1999) and older users often abandon assistive devices over time (Goodman, Tiene & Luft, 2002). Reasons for student reluctance to use optical low vision aids include self-consciousness, embarrassment, tired eyes, and a perception of being slowed down by the device (Mason, 1999). A CCTV has the disadvantage of bulk and is usually not moved from one place to another.

Teachers often use blackboards or whiteboards to communicate visually with students during regular teaching and learning episodes in classrooms. Irrespective of their reading abilities, students with limited distant acuity find it difficult to read text or view materials that are either written on blackboards or whiteboards or displayed in classrooms (Fellenius, 1996). Currently, teacher aides or peers often support students with low vision in regular classrooms by sitting beside them and copying or reading content from a range of resources presented by teachers. A study in UK mainstream secondary schools confirmed that sighted peers are called on consistently to help low vision peers complete tasks in classroom settings (Mason, 1999). Mason found that 40% of sighted friends reported helping visually impaired students with reading from blackboards, whiteboards, OHPs, texts, or worksheets. Their comments suggested that, "without their help the student with a visual impairment would be unable to keep up with the rest of the class" (p. 96). Visually impaired students also believed that the low vision aids prevented them from working at the same pace as their peers. The study found that low vision learners in inclusive secondary school classrooms prefer the support of teacher aides and peers to the use of low vision aids when working (Mason, 1999). Although beneficial, however, these supportive practices may facilitate dependent behaviours in low vision learners and be detrimental to progress in further education when this support may not be readily available. There is also the question raised by Mason as to whether student perception of being slowed down by the aid agrees with reality. She suggested it may be associated with lack of confidence in using the aid and Felenius (1996) noted the need for sensitivity to student motivation and for adequate training in the use of aids. The level and quality of instructional services provided to low vision learners has been questioned, including instruction in literacy and the use of technological aids (Corn & Koenig, 2002).

Social integration is seen also to be a vital, yet often difficult component to address when planning for effective inclusive educational programs for visually impaired students (Rodney, 2003) and social isolation is believed to be a major barrier to successful integration (Hatlen, 2004; Sacks & Wolffe, 1992). Research with visually impaired adolescents has highlighted the fact that they spend a large amount of time alone and work harder to maintain friendships (Sacks & Wolffe, 1998). Some adolescents even consider themselves to be "outsiders in the hierarchy of the school culture" (Rosenblum, 2000, p. 444). Hatlen (2004) believed that environmental information, spatial knowledge and nonverbal communication are different for visually impaired students and their sighted peers. He suggested that "the educational modifications necessary for students who are blind or visually impaired to access learning experiences may, in themselves, be barriers to social interaction", as the use of special equipment may emphasise differences between the two groups (Hatlen, 2004, p. 677).

A main aim of the research reported here was to develop and then evaluate a portable computer system designed to assist low vision students to acquire academic, communicative and social knowledge within inclusive classroom settings. A major interest is in the development of literacy (including numeracy) skills in these students and this paper describes a promising system for use in regular classrooms. The system is designed to facilitate access to classroom information in a way that motivates students for continued use. Ease of use and student motivation were considered as keystones to the ongoing benefits of the system. There is also a possibility that the system can decrease student isolation and facilitate interaction with peers, providing subsequent benefits to communication and shared knowledge.

Description of the project

Students from Griffith University's School of Computing and Information Technology worked with researchers from the "Eyes on Our World" Visual Impairment Lab to develop a computerised system to address problems low vision learners experience when working in inclusive education programs. The team developed a system that enables students with vision impairments to view written text and visual images or objects more effectively in indoor classroom settings. A major purpose is to design a system that will encourage the development of literacy and numeracy competence in students with vision impairments. Three students with vision impairments used the system during regular programs in inclusive classrooms as part of a trial investigation. These participants provided valuable feedback about the system that has guided its design throughout the research.

Method

Participants

The participants and school contexts used in this research were purposely selected. Participants expressed their willingness to trial the system and to provide feedback to the researchers on its use after an introductory presentation of what was involved when using the system. Participation in this initial trial investigation was voluntary. One primary school student, one secondary school student and one university student with severe low vision used the system during regular classroom-based teaching and learning periods. School principals, teachers, and the parents or guardians of the two primary and secondary school students gave consent for the children to participate in the trial. The university student volunteered to trial the system during lectures and tutorials.

The system

The system consists of specialised software designed for use with a personal laptop computer, rotating web camera, and joystick or mouse attachments. When using this system, students with low vision can remain stationary at a desk, while they scan, zoom in and out, focus on, and review self-selected information from any part of a classroom setting within a 7-metre radius, for enhanced participation during regular classroom teaching and learning periods. For example, students can use the technology for a better view of the blackboard (or whiteboard) or to look more closely at the facial expressions or gestures of their teachers or peers. The software allows students to access writing and reading/viewing areas of the program at the same time through the use of a split screen facility. They can zoom in to focus on written text (one line or several sentences) or visual images while simultaneously recording notes or completing written components of tasks. Students can manipulate the program and adjust font or image sizes, colour, or contrast to suit their own individual visual needs.

Procedure

Members of the research team introduced the participants to the system and its functions in their regular classroom settings. Students and teachers or teacher aides were shown how to use the web camera to scan the room, zoom in and out, and focus on written text, images and people in the classroom. The writing function of the program was also demonstrated. Once participants appeared comfortable using the system, they were asked to use it in their own school contexts. A qualitative approach using observation and interview techniques was used for data collection. Teachers, teacher aides and students wrote notes on their observations and experiences with the system. This feedback was collected by researchers at regular intervals throughout the trial period and supplemented by further information gained during informal interviews.

System design procedures followed a participative and interactive research approach in which individuals participate actively in the research process and gain from the practical implications of the work (Adams & Langdon, 2003). In this research project, the needs of students with low vision are first acknowledged and then applied progressively to the stages in system design. Hence, the system has gone through various modifications and enhancements since its conception. The feedback provided by individual users was integral to identifying and implementing changes that enhance system use and potential. An adaptation of the theory underlying these procedures provided the research team with "a conceptual overview of users' requirements to guide their design choices" (see Adams & Langdon, 2003, p. 610 for Simplex Theory 1).

During the trial investigation, students, teachers and teacher aides were encouraged to make recommendations about system use and to suggest modifications to its design as part of this participative research process.

Research questions

Several researchers have noted the need for adequate instruction in the use of visual aids (Corn & Koenig, 2002; Felenius, 1996). Consequently one of the aims of this research project was to design a system that would not require complex training before it could be used effectively by students with visual impairments.

Efficacy of instruction and student performance with the system was considered in terms of some of the design questions described by Adams and Langdon (2003) with respect to various zones. For example, with respect to the *input and output zones*, is the modality input adequate? Are the sensory parameters of the user well supported? Does the user have the necessary skills to respond adequately?

The *zones of working memory and long-term memory* were also considered. Are there too many demands on working memory? Does the system support long-term learning?

Questions considered regarding the *executive function zone* included the following: Does the design require too many, too complex operations? Does the system require a level of task coordination that is too detailed to learn easily? Does the system make it difficult to track and monitor current progress on tasks? Do those who will use the system have the necessary organisational skills?

As motivation has been regarded as a key factor in determining ongoing use of low vision aids, (Felenius, 1996) a second aim was to examine this aspect of student behaviour. Do students and teachers report interest in continuing use of the system? This is of special significance if the system is to encourage ongoing development of proficiency in literacy and numeracy.

The final aim was to explore the effect of using the system on participation by students with visual impairments in classroom teaching and learning interactions and in social interactions. Therefore, is there any evidence of increased participation during use of the system?

Results

Instruction in use of system

The vision impaired students and their teachers reported that the technological equipment used in conjunction with the system was easy to set up. Observations showed that both the secondary school student and university student quickly learnt to organise the system independently for class lessons within 20 minutes. The visual display was enhanced by adjustments in colour, contrast and font to suit the individual student, and two of the students showed proficient motor performance in operating the system.

However, some aspects of system use in relation to executive functions and output zones required a level of task coordination that was too detailed at times. John, the secondary school student, did not appear to have the necessary skills to respond adequately to use of a joystick to control web camera movements. When first introduced to the system, John presented as an unconfident user of the joystick, and its use appeared to be a hindrance to him (Researcher observation, 13/04/2005). During a subsequent visit, the secondary school teacher suggested that John would rather have an alternate way to control the rotating web camera as use of a joystick was not successful for him (Secondary school teacher, 27/04/2005). As a result, researchers are investigating whether the creation of Function (F_) keys to make specific features of the technology more visible and accessible for users will be useful. For example, Function (F_) keys could be created to allow automatic access to the writing area and to control directions of the web camera. Furthermore, connection of a smaller, lighter, less expensive joystick that can be formulated to work with any appropriate software program that can be downloaded free from the Internet, may be useful as individual users can format buttons to control various functions of the system for themselves. As a result, individuals would be able to select zoom-in and zoom-out panning directions and speeds for the rotating web camera. They could select a 'pan-stop, pan-stop' motion to pan around a classroom or decide to implement a more continuous panning or 'scanning' motion by continuously holding down their finger on the joystick button to facilitate quicker use and viewing of images in a classroom.

Good eye-hand coordination and prior experience of using a joystick appeared to determine how efficiently students interacted with the system. James, the primary school student, who frequently played computer games in his own personal time, indicated that he found manipulation and use of a joystick an easy task. It is advisable to take an individual focus when considering the needs of low vision students, including the use of technological aids (Fellenius, 1996).

Motivation to complete teaching and learning tasks

Low vision students and teachers were motivated to use the system. Comments such as, "The class teacher wants to hide the equipment so you can't take it back!!" (Primary school teacher aide, 12/04/2005) and "James is enjoying using the technology" (Primary school teacher aide, 11/04/2005) supported this view. Emotional factors can influence performance on cognitive tasks (Preece, Rogers, & Sharp, 2002), and the importance of student emotional response to learning behaviour was recognised during the design process. The positive nature of student involvement with this system provides an opposing view to reports of student reluctance to use low vision optical and CCTV aids (Fellenius, 1996; Mason, 1999).

Motivation to use the system was also evidenced through observation of student willingness to persevere in solving problems regarding its use. The three students displayed characteristics of increased independence and enhanced problem-solving abilities when completing learning tasks using the system. They took control over use of the system and modified features to suit their own visual needs. John, the secondary school student, became "An efficient user of the technology and readily problem solved while using the program during explorations" (Secondary school teacher, 27/04/2005).

Feedback from John, the secondary school student, alerted the researchers to a need to modify the portability of the system. This student commented on the inconvenience of carrying the equipment from one classroom setting to another during regular teaching and learning periods. He felt that the cases used to house all the equipment were, "A bit big and cumbersome to be carrying about the school all the time" (Secondary school student, 27/04/2005) and suggested that a smaller laptop be used to alleviate this problem. This issue if left unattended could have had the potential to influence this student's motivation levels where he may have become reluctant to use the system. Future plans for the system include investigating alternate ways to address portability issues. Possibilities include the use of lighter and smaller web cameras and joysticks and options for decreasing the amount of connecting cords needed to link the system. Furthermore, these modifications to enhance portability of the system could provide opportunities to facilitate literacy and numeracy development by linking experiences in school, home, and the community.

Participation in class teaching and learning interactions

The students were observed using the system to view numerous examples of text and visual images displayed around their classrooms. They were able to interpret and apply this information to the tasks that their teachers set, thus suggesting learning in general and enhanced acquisition of literacy skills and strategies. Teachers reported that the technology provided opportunities for their low vision students to immediately access written text as it was added to blackboards or whiteboards. The students were then able to work independently with the system. Teachers suggested that, as a result, the students did not appear to be quite so isolated from the teaching and learning activities going on about them in their classroom settings. The primary school teacher aide commented that she liked the way James was able to follow board work, for example during Maths lessons. She thought she could keep James on task for longer through use of the system. Thus, the system did not appear to place too many demands on working memory and seems to have the potential to support long-term learning.

Some reports indicated, however, that modifications to the system would enhance its use for some individuals. For instance, it was reported that James, the primary school student, found it, "Fairly difficult to keep up with the teacher's pace" during mental maths board work. His teacher aide commented that, "By the time James focused and then zoomed in for the particular number or example, the teacher was on to the next example". This was despite the teacher's pace not being excessive. Consequently, the teacher aide reported that "It would be better if the (camera) eye could turn faster than it did so James could get information e.g., numbers from the board before the teacher moved to the next example" (Primary teacher aide, 11/04/2005). This feedback has been considered by the researchers who are now investigating alternate web cameras that have faster rotation speeds which should allow students to be able to scan and pan classroom settings more readily at speeds to suit their individual needs. Alternatively, connection of the smaller, lighter, button controlled joystick discussed above may provide a solution to this problem.

There were other conflicting results in terms of the system's ability to support students' sensory parameters (Adams & Langdon, 2003). A positive benefit for James, the primary school student, was that he could engage effectively while completing multiple classroom-based tasks simultaneously when using the system. For example, during a lesson on colonisation, James was observed viewing a map of the world on a classroom wall while reading from a printed worksheet placed 2 metres away from the camera at the same time (Primary school teacher aide, 07/04/2005). However, when James came to use the writing area of the system, he found it too small. As James required a very large font of at least size 36 to be able to view text adequately, his teacher aide believed that for long-term use of the system, settings would need to be changed to suit him (Primary teacher aide, 07/04/2005). In response to this feedback, researchers are now investigating various options to increase the size of the writing and reading/viewing areas, for example, by using a mouse magnifier instead of a larger computer screen. Different software alternatives to provide voice output are also being considered. The advantage of a mouse magnifier is that space will not be taken from any image on the computer screen. The normal menu bar will be replaced, resulting in a larger screen viewing area and the mouse magnifier will allow individual enlargement of icons, rather than enlargement of all icons. Although Windows software for a personal computer includes a magnifier, there are freeware alternatives that offer much greater magnification. The advantage for this project is that a mouse magnifier will preclude the need for a larger screen and enhance the portability of the system. There are also various programs available for text-to-speech. Some are freeware, such as ReadmePlease, but extra features are available for a small charge. Modifications such as magnification and voice output are important as they enable users to tailor specific features to meet their individual needs.

Peer interaction within classrooms

There was some evidence that the system has the potential to increase opportunities for low vision students to interact with others more effectively. Academic and social isolation appear to have decreased during teaching and learning sessions. The primary school teacher aide said, "Prior to using the equipment, James would hide behind his slope board or put his head down. With the equipment, James is much more a part of the class – not so isolated" (Primary school teacher aide, 12/04/2005). Teachers also reported that students with low vision could interact more positively during some types of classroom activities when they used the system. For example, James, the primary school student, reacted positively during the viewing of television programs in the classroom. "James found it excellent when the class watched 'Behind the News' on television" (Primary school teacher aide, 06/04/2005). In this instance, the system facilitated this student's positive inclusion in a social activity in a way that had not been possible previously. Furthermore, James' use of the system was seen to improve his working relationship with other students. On one occasion, James and a hearing impaired classmate worked together, alongside their teacher aide, to complete a task. The visually impaired and hearing impaired students were seen to gain mutually from use of the system on this occasion.

Sighted peers were observed to demonstrate high interest in student use of the system during classroom interactions. The technology appeared to make John, the visually impaired secondary school student, 'more visible' to sighted classmates who expressed interest in the equipment he was using and how he used it. They demonstrated an eagerness to be involved in using the system too. This suggests that, by providing opportunities for low vision students and their peers to work collaboratively on group tasks, the system may foster the development of social skills. In addition, by enhancing access to the non-verbal expressive behaviours of teachers and classmates, the system provides opportunities for the students with visual impairment to supplement the language they hear and to contribute to their growth in communicative and social knowledge.

Conclusion

Preliminary findings reported in this paper suggest that the system does not require complex training and that its use had positive implications for the visually impaired students involved in this trial investigation. Observations suggest that visually impaired students' acquisition and growth of academic, communicative and social knowledge may be enhanced through use of the system. Visually impaired students' social interactions, independence, and verbal, non-verbal, and written communicative practices were assisted as they engaged in their inclusive education programs. Information from the low vision students, their teachers and teacher aides has provided essential advice to guide current designs and future developments of the system. Once current and ongoing technical modifications are applied, future trials will continue the participatory research described in this paper. More detailed measures over time will show whether the observed motivational effects persist and whether the apparent increases in on-task learning are reflected in higher levels of achievement.

In addition, the production of a "Do it yourself" manual may be useful to assist users of the system. This manual could suggest convenient and affordable options for choosing and assembling technological equipment required for use of the system to better address the needs of individual users. Furthermore, the less expensive technological options could bring the benefits of the system to disadvantaged communities and small adaptations could assist lip reading of teacher information by students who are deaf. The researchers recommend staff training in the use of the system for teachers and teacher aides who teach in mainstream, inclusive education programs. This should provide practical strategies to support the individual literacy and technological needs of students with disabilities, especially those with low vision.

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