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Repairing the Assistive Technology Aortas of Students with Vision Impairments

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ABSTRACT

A wide variety of technology is currently available to students with vision impairments at school and at home. It should not be assumed that every classroom, or subject teacher, nor every specialist teacher has a thorough knowledge of the many devices that might meet a student's particular need. The focus of this paper is upon fundamental concepts that considerably enhance teacher and learner effectiveness in using technology. The paper's title reflects a definition from Afferbeck Lauder's celebrated dictionary of "Strine", or everyday Australian conversational speech, in which "Aorta" means "They aught to". The authors propose three "aortas" that teachers of students with vision impairments must consider in the provision of technological supports to their students.

- Aorta spend time on the selection of appropriate equipment,
- Aorta be very concerned with classroom set-up; and
- Aorta take steps to influence lighting, contrast, colour, noise levels and accessibility.

1. INTRODUCTION

Vision impairment is the loss of visual function of such magnitude that special aids and use of other senses are necessary to achieve performance ordinarily directed by visual clues. Students who have vision impairments range from having total absence of sight to varying degrees of useful vision. Because a student is vision impaired, it should not be assumed that he or she is unable to participate in educational activities. There is for students who are blind or vision impaired a wide variety of special aids and/or accommodations that facilitate learning in the classroom setting.

There are few comprehensive and consistent Australian prevalence data on school-aged students who are blind or vision impaired as a group, so that little is known about those who comprised its membership. It is widely known, however, that in Australia, students who are blind or vision impaired attend all the types of schools – government (public), Independent and Catholic (private) that are available to their sighted peers. A survey recently conducted for the Commonwealth Department of Education**,** Training and Youth Affairs (Jolley, Steer, Gale & Gentle, 2001), indicated that most attend publicly funded schools. Respondent estimates revealed that there were (as of April 2001) approximately 4,500 students who are blind or vision impaired attending Australian public and private sector primary and secondary level systems or agency educational programs. This estimate should, however, be treated with reservation.

Of the 4,500 students reported, some 2,700 did not have an intellectual disability that precluded them from using print or braille to attain literacy and numeracy. Estimated numbers

by gender indicated that 755 were female and 1,183 male. There was no information on the gender of 412 students

The academic success of students who are blind or vision impaired, whether in special, integrated or inclusive school settings depends on a variety of factors. Among these is their ability to access the classroom curriculum.

Curriculum access for blind and vision-impaired students requires provision of the same books and resource materials as those provided for sighted students. However, these need to be provided in an appropriate format, for example, braille, large print, e-text and audio), at the same time and at the same level, including the same book edition (Kelley & Gale, 1998; Mason & McCall, 1997; Mosen & Small, 1996; Royal National Institute for the Blind, 1998). Gale & Cronin (1998) have argued that educational goals for students who are blind or vision-impaired should be the same as for sighted students, with some modifications and adaptations according to individual needs.

Kelley & Gale (1998) have contended that literacy and numeracy acquisition, particularly through the medium of braille should involve instruction across all key-learning areas, to the same level of proficiency expected of the student's sighted peers. Students should be exposed to text in the full range of contexts, formats and genres, as for example, environmental, factual and fictional. In Australian schools, teachers are free to select the prescribed textbooks until shortly before the year or semester begins. This is quite a common occurrence in schools but a practice that can cause extensive problems for students who are blind or vision-impaired and who require texts in accessible formats. Such texts take a long time to prepare and if students are without a text or are forced into using the same text, but an earlier edition in which the page numbers, content and layout may differ from the latest edition, they will be severely disadvantaged.

Given the above constraint, appropriate adjustments can be made to the curriculum that render it more accessible and, as Casimir and Alchin, (2001) have pointed out, thus enabling both teachers and students with special needs to take advantage of the many rich learning opportunities available to them. For teachers, designing a classroom with assistive technology that is accessible for students with significant vision impairment can appear a daunting task. Despite such initial apprehensions, curriculum accessibility can be increased with minimal disruption to others in the class through the use of assistive technology.

The term assistive technology refers to items, or pieces of equipment, or products, whether acquired commercially, or off the shelf, modified or customised, that are used to increase, maintain or improve the functional capabilities of individuals with disabilities (Kochhar & West, 1996). The effectiveness of a piece of equipment is dependent on its appropriateness to a variety of situational variables. For example, user characteristics, setting demands, particular features of the technology itself, as well as a number of cultural factors (Lewis, 1998). These all require careful consideration prior to deciding whether and how to use assistive technology.

This brief paper will outline some of the fundamental concepts that considerably enhance teacher and learner effectiveness in using technology. It is not possible to provide a fully comprehensive coverage of all aspects of assistive technology due to the vast number of devices and supports that can be classified as assistive technology. These include a widely diverse range of materials, services, systems and devices. It is useful to classify such devices into 'low-tech' and 'high tech' categories. Those commonly used in schools include positioning equipment, mobility aids, communication devices, computer applications,

electronic interfaces that can be categorised into input and output devices, adaptive environments, an assorted array of medical equipment and prostheses (Parette, Brotherson, Hourcade & Bradley (1996). This paper will, however, focus upon those forms of assistive technology that primarily help students with vision impairments gain access to information, both print and electronic, and as well, facilitate written communication. The key to taking advantage of the opportunity these tools offer, as Koenig and Holbrook (2000) have indicated, is to give students access to the appropriate assistive devices when needed.

With this important goal in mind, the paper's title reflects a definition from Afferbeck Lauder's celebrated dictionary of "Strine", or everyday Australian conversational speech, in which "Aorta" means "They aught to". (Morrison, 1965). The authors, therefore, propose three "aortas" that teachers of students with vision impairments must consider in the provision of technological supports to their students. The first of these has to do with the importance to teachers and students of adopting a protocol to guide them in selecting the appropriate equipment.

2. AORTA SPEND TIME SELECTING APPROPRIATE EQUIPMENT.

At one time, as Bishop (1996) has pointed out, students with vision impairments had only a typewriter, tape recorder, Talking Book Machine and/or a braille writer as special equipment. Today, the available assistive technology has the potential to increase student and teacher control over a variety of educational materials and can "allow direct contact with classroom activities" (p. 104). There are systems and software to enlarge print spontaneously, software that enables computers to "talk", self-contained electronic equipment to allow students who are blind to take notes or read print; and software that will translate braille to print and vice versa. The student with a vision impairment in the classroom is only limited by the availability of technology and the skills of the teacher in enabling him or her to use it.

The significant promise of technology for students with vision impairments is accompanied by significant challenges for their teachers. It is critically important, for example, that student's are taught to operate efficiently in technological environments. This is because the endemic complexity of much assistive technology requires direct instruction from qualified and technologically competent teachers of students with vision impairments (Kapperman, Heinze & Sticken, 1997). In this regard, Kelley, Finley, Koehler and Picard (2001) have reported that a key component of success in integrating technology for students with vision impairments into the curriculum, is the collaboration between classroom and specialist teachers and technology instructors.

The arrival of a piece of complex assistive technology in a classroom will likely be greeted with excitement by the student with a vision impairment as well as by the specialist teacher. However, it might sometimes be regarded as a threat to the competence and an intrusion on the time of the class teacher. Some classroom teachers in fact do not view the teaching and supporting of assistive technology for the student as part of their role. It is therefore essential that initial in-service and on-going support is available to the student, the classroom teacher, the school staff generally, and to the specialist teacher.

The efficiency with which a student who is vision impaired uses sensory information in the learning process is, as Koenig and Holbrook (2000) have indicated, essential to the construction of that student's individual educational plan (IEP). Issues affecting curriculum access via assistive technology become additionally important to both teacher and student. There must be a systematic decision making process to select any assistive technology device

that enhances an individual's ability to access or engage in critical tasks (Lueck, Dote-Kwan, Senge, & Clarke. 2001). The implications of assistive technology as a means of accessing the student's instructional program are best determined through specialised assessment processes that are, as Koenig, Holbrook, Corn, DePriest, Erin and Presley (2000), have stated, unique to the needs of students who are blind or vision impaired. These specialised assessments in the school or classroom setting include the following:

- *The functional vision assessment*
- *The learning media assessment,* and
- *The assistive technology assessment*, aimed at determining the appropriate options for using adaptive technology to meet individual student needs and the selection of access devices for computer input and output.

There are of course, overlapping areas in these three types of assessment.

2.1 Specialist teacher's role

Teachers of students with vision impairments generally have primary responsibility for conducting specialised assessments. They take a lead role in conducting a functional vision assessment and a learning media assessment. In New South Wales for example, this role has also been assumed by the Assistant Principal or Executive Teacher (Vision Impairment). A teacher of students with vision impairments may conduct an assistive technology assessment, or a specialist who has had specific training in the special technology needs of such students may conduct it.

The specialist teacher gathers information from a number of specialised assessments and uses it to design, as part of a team, an appropriate Individualised Educational Plan (IEP) for the student. The particular role of the specialist teacher is to do the following:

- Conduct the functional vision assessment
- Conduct the learning media assessment
- Conduct a screening of assistive technology needs;
- Ensure that a comprehensive technology assessment has been conducted;
- Collaborate with parents and other IEP preparation team members to gather objective information on student strengths and weaknesses, related to use of the student's sensory systems;
- Offer recommendations for instructional programming literacy media needs, and assistive technology needs on the basis of the specific assessment results, and
- Ensure ongoing needs assessment using the specialised assessments to gather and synthesise information, at least annually.

The extensive and continuing development of a plethora of new equipment available for people who are vision impaired means that specialist teachers are faced with the daunting task of trying to keep informed about not only the available equipment but also with the continuous developments in the field. Downie (1996) has stated that a major challenge for educators of students with vision impairments is that it is not possible for individuals to hope to keep abreast of all innovations. It is essential that teachers of students with vision impairments have information and access to the range of available equipment. They also need access to the commercial producers of equipment as well as to individuals who are already using the equipment successfully. A teacher of students with vision impairments requires time in her/his busy caseload to investigate, evaluate and select the most appropriate equipment for individual students.

2.2 Assistive technology assessment

A comprehensive assistive technology assessment identifies the technology that a student will need to complete a variety of tasks in his or her educational program. An effective assessment should be part of a team process. As well as those who normally attend the student's IEP meeting it is advantageous to include an assistive technology specialist, should one be available, and possibly a vendor or product representative. These additional team members are crucial to successfully completing the assessment.(Koenig & Holbrook, 2000). In this regard the time taken to complete the assessment is an important issue, with team and student being encouraged to take "as long as is necessary".

The comprehensive technology assessment includes a review of background information on the student and an initial assessment by the specialist teacher, together with a follow-up assessment by an assistive technology specialist (should one be available). Once the recommended technology has been put in place, the specialist teacher and the other team members conduct ongoing assessments and periodic re-evaluations to ensure continuity of support.

2.3 Gathering information

The first step in completing the assessment is to secure parental permission to collect comprehensive background information. The specialist teacher typically undertakes this task. Information from the student's permanent records, together with data from formal evaluations and observations as well as information on the student's previous use of assistive technology is necessary. Previous evaluations might have provided data on the student's technology skill levels. Information should be gathered from the following sources:

- Medical eye examinations
- Clinical low vision evaluations; (Langley,1999).
- Learning media assessment; information on the primary learning medium, additional literacy tools, reading efficiency and comprehension;
- General medical, psychological and academic evaluations;
- Informal assessments and observations by teachers (Sewell, 1997). This should include information on the student's use of vision for everyday tasks; preferred font size, comfortable reading distance, positions for materials, lighting preferences and visual stamina.

Background information is also needed on the quantity of printed material that the student needs and the settings in which the information is to be accessed (Koenig & Holbrook, 2000). It is helpful to know the magnitude of tasks and whether or not they are to be completed in class, in a lab, the gym a media centre or at home.

2.4 The Checklist

Once the background information has been collected and reviewed, the assistive technology assessment can commence. The specialist teacher conducts the initial assessment. It typically involves determination of student strengths and needs in the following areas.

- Gaining access to print information though regular print, large print, optical devices, non-optical devices, braille, auditory modes;
- Producing written communication with standard tools and technological devices;
- Gaining access to computers through visual, auditory and tactile modes, and;
- Inputting information into computers using keyboards and other devices.

At this point the teacher might use the comprehensive Technology Assessment Checklist that is presented by the Texas School for the Blind and Visually Impaired at its homepage (www.tsbvi.edu/publications/kit.htm)

Certain data requested in the checklist might be available from those already collected. If they are not, then direct assessment of each item is required. Should the teacher not have access to some of the technologically advanced options mentioned in the checklist, a technology specialist as part of a comprehensive technology assessment can evaluate these options. All items not assessed should be marked N/A.

In preparing for the initial assistive technology assessment a quiet room is needed, so that the teacher, student and an observer can work without distraction. Since the assessment protocol requires the student to complete many tasks there is danger of physical fatigue. It might be best advised to complete the assessment tasks over several days.

Once the technology selection has been narrowed to one or two specific devices, it is often useful for the student to trial the equipment in situ. This gives the student an opportunity to actually use the device(s) in an environment that is familiar and permits the teacher and assistive technology specialist an opportunity to observe and note difficulties and obstacles.

The Assistive Technology Assessment Checklist has an important role in the process of designing an IEP for a student who is blind or has a vision impairment. Given the specialised nature of the assessment, the special teacher takes the primary role in the assessment protocol, reporting the results and offering useful recommendations. Assessments for educational purposes typically rely on informal measures, observations and interviews, but conclusions must rest on objective data.

A student with vision impairment will benefit from such an assessment since it explores and documents his or her unique requirements. The information thus obtained is used to develop the comprehensive plan from which the student's school year is designed.

3. AORTA BE CONCERNED WITH CLASSROOM SET-UP.

There are, as Castellano and Kosman (1997) have pointed out, many ways of setting up a student's classroom work area that aim at maximising independence and seating that aims at ensuring full participation. The following focal areas require teacher consideration:

3.1 Desk size and placement

A student with a significant vision impairment will require a large work area that can accommodate a braillewriter or notetaker a braille or large print book, an answer sheet, perhaps a tray of "manipulatives", maths counters and the variety of small items often used in classrooms.

An L-shaped arrangement or a larger than usual desk is necessary. It is important not to place the desk or workspace in an isolated (and therefore isolating) spot in the classroom. It is essential, as Castellano and Kosman, (1997), have indicated, that the child who is blind is seated with classmates in order to socialise and be a part of the class (p. 119). If an aide assists in the classroom, teachers should ensure that the desk is set-up for the student rather than the aide.

3.2 Introducing the technology

Introduction of others to the technology will be contingent on the student's first having accepted it. Some students, for example, will want as little fuss as possible made about its introduction. For others, a planned introduction program can provide useful learning for all concerned.

When introducing a particular student with a vision impairment to assistive technology in the classroom, it can (with the principal user's prior agreement) be advisable that teachers plan an activity for the whole class that involves a demonstration of the devices and their use (Casimir & Alchin, 2001). Such an activity, as Carney and Dix, (1992) have pointed out, serves several purposes. First, it informs the other class members of the student's special needs and introduces them to the piece of technology and its uses. Second, it permits the teacher to establish ground rules governing its use, and third, because certain types of technology are associated with recreational purposes, for example, the speech synthesisers used in popular toys, it provides an opportunity for the teacher to explain the more essential purposes of the equipment. It is likely that in inclusive settings, classmates who are given the opportunity to openly obtain information about students with special needs are, as Foreman (2001) has pointed out, more likely to treat the student with greater respect.

Teachers, according to Carney and Dix (1992), can best make use of assistive technology by selecting target activities that might for example, include some or all of the following:

The activities should be motivating and enjoyable

They should take place each day or at least several times a week

The activities ought to present opportunities for enhancing independence in such areas as written and verbal communication, mobility, self-care, numeracy, vocational skills and environmental controls

They should be activities that the student(s) are not able to complete without the assistive technology.

3.3 Materials and equipment arrangement

The student will need to be able to locate his or her books, folders, notepads, braille paper and a variety of other learning "tangibles". These items need to be accessed independently and should be within easy reach. An expandable vertical file with several slots works well for holding most of these items (Castellano & Kosman, 1997). Notebooks and folders can be labelled in braille with the braille taped label placed where the title of a book would be, so that it is easy to locate with the fingers. Horizontal stacking trays are another option with each tray appropriately braille labelled.

Braille and large print versions of some school texts can run to several volumes, so that it is advisable to have only one volume of each text at the student's desk. The braillewriter or notetaker will probably remain on the desk all the time. Thought needs to be given to providing non-slip pads to ensure that books and papers remain on the desk. A tray with raised edges or a box lid is useful for holding "manipulatives". Small paper cups or film cylinders can be fastened to the desk with Bluetak in convenient places to hold, for example, pins, magnets, paper clips or braille name labels

Other important issues have to do with student safety and include raising awareness about access to power points, ensuring that the teacher, student and class peers do not trip over electrical cords.

3.4 Organisation: Foundation of independence

It's up to the adults in the life of a student who is blind or vision impaired to set up systems for the student's use. This is done automatically for sighted students. For example, as Castellano and Kosman (1997) have pointed out, bookbags are manufactured to fit print books; ordinary school desks can easily accommodate the materials a sighted student needs in class. When taught good organisation skills, a student with a vision impairment will be able to work efficiently and independently (Bishop, 1996). However, unless such students have skills and behaviours modeled for, or directly presented to them they might not be able to understand how the world is organised. Since many students with vision impairments are unable to scan a room, or easily locate an object, organisation is an essential skill.

It becomes essential, therefore, to remember that the successful use of assistive technology requires high levels of organisational skill. For example, students need to have electronic content organised appropriately, with the equipment properly charged, as well as any required peripherals; head phones, floppy disks and additional disks, ready to hand for prompt use as required.

The following suggestions for teaching organisational skills have been adapted from Kelley and Smith (2000):

- Encourage the student to retrieve and replace items from the classroom storage areas. Verbal suggestions might be given on ways of better organising the stored items, so that they might be more efficiently and safely retrieved.
- Teach the student to arrange objects, for example, books, or "manipulatives" for maximim efficiency and effectiveness. Adequate storage space and the consistent placement of objects in the same places will help the student.
- Establish routines within the school day, remembering to re-charge electronic equipment overnight.
- Have the student share responsibilities with classroom peers.
- Have the student maintain a file (either in notebook or data disk format) on ordering and repairing such equipment as braille writers, canes and adaptive devices.
- Have the student maintain a file on important telephone/fax numbers and email addresses.
- Keep bus and other transportation schedules in a particular place.
- Have the student make a list of needed items prior to a shopping expedition (pp. 578-9).

Organisation is for the student who is blind or vision impaired, as Gale, d'Apice, Freeman, Payne and Tierney (1998) have pointed out, the key to the acquisition of all independence skills. It must be taught from an early age. Thus it is an important aim for teachers and parents to develop, particularly with regard to the use of assistive technology in the classroom, the life-long ideal of "a place for everything and everything in its place" (p. 229).

4. AORTA TAKE STEPS TO INFLUENCE LIGHTING, CONTRAST, COLOUR, NOISE LEVELS AND ACCESSIBILITY.

Several important environmental factors require teacher consideration before a student who is vision impaired is provided with assistive technology. Among these are the influences exerted upon learning by a variety of factors, among which are lighting, noise levels and accessibility.

4.1 Lighting and Illumination

There are differences in lighting requirements, as Robbins (1998) has pointed out, for students with low vision. As Robbins (1998) has pointed out, even in groups with the same clinical diagnosis it is possible to find some students who function best with very high light levels, while others require low levels. It is important, therefore, that the teacher take a somewhat flexible approach to classroom lighting. In some instances advice on lighting levels from an ophthalmologist is necessary.

Illumination, as defined by Corn and Koenig (2000), is "the amount of light on a surface" (p. 135). It is measured in footcandles of power and the term also relates to the type of light that is present. High levels of illumination when using assistive technology in the classroom is best provided by some form of angle poise lamp, on a flexible arm that allows positioning at just the right angle and distance from the task. The amount of light falling on the task varies, not as the distance between the light source and the task, but as the distance multiplied by itself- the so-called inverse square law (Robbins, 1998, p. 293). If the distance between the lamp and the task is halved the illumination increases fourfold. If the distance is reduced by a third, the increase is ninefold.

Angle poise lamps are available with incandescent, fluorescent and halogen globes and it is unnecessary to use a particularly strong globe to get high illumination. Some lamps, particularly of the fluorescent and halogen type emit heat, so that it is sometimes difficult to work near them for long periods.

Koenig and Holbrook (2000) have provided a number of basic and important questions for teachers on lighting as it affects the use of assistive technology in the classroom. These are as follows:

With regard to lighting in the classroom:

- Is there too much light and/or glare?
- Is there not enough light?
- Is it the correct kind of light for the task?
- Can the ambient and overhead light be controlled by shields around a computer monitor (top and sides)? (p. 138)

4.2 Contrast and colour

The use of contrast can be beneficial to many students with low vision.

Traditionally, vision has been measured using such high contrast tasks as black letters on a white background. Contrast adaptations are not difficult to make, but many teachers do not think of them until some adaptations have been identified (Kapperman & Koenig, 2000). Thus it helps if the teacher can encourage the student to ask him or herself frequently "What could I do to improve the contrast in this situation?"

Some basic suggestions for teachers with regard to the use of contrast in their teaching include the following:

- Students with partial sight will often benefit from the use of coloured chalk, which gives the greatest amount of contrast (e.g., bright yellow chalk on a green or black board, or white letters on a blue background on a computer screen). If extensive use is

made of diagrams or numbers written on the board or overhead, it is extremely helpful for the student with a vision impairment to have a copy of the class notes
- Providing large print, high contrast classroom handouts is very helpful and can be done on most laser printers using 18 or 24 point type.

Avoidance of visual clutter (Gale, Kelley & d'Apice, 1998) is another area of concern for the teacher. It relates to material in which objects or print are crowded or difficult to isolate from the background and are therefore difficult to distinguish from one another. Visual clutter is often a feature of highly decorated primary school classrooms as well as pictures and diagrams in textbooks. Its result is visual fatigue (Gale & Steer, 2001), the tiredness or stress in a student with vision impairment caused by the act of looking

Colour too, has important uses for the student with low vision. For example, it is useful to use colours as coding systems for filing paper work or to colour code school texts for various subjects; green for English, Orange for maths.

Some persons with low vision who have colour deficiencies, as Corn and Koenig (2000) have pointed out, do not find techniques for manipulating colour very helpful. Further, certain colours become more visible and therefore more useful under particular lighting conditions. Some of the colours that fully-sighted people think are highly visible, and not particularly so to students with low vision, for example, bright red on a black background). Because of the idiosyncratic nature of colour perception, teachers and students must experiment to discover the colours that most facilitate learning.

4.3 Noise levels

Since a student who is vision impaired relies on hearing to obtain information, extraneous noise is distracting and makes it difficult to concentrate on the information being presented. Further, the student often experiences difficulty due to noise, in focusing during small-group discussion when there is more than one group functioning. Background noise is also a distractor when students with vision impairments depend on taped lectures for review and reinforcement. Tape recorders need to be placed in close proximity to the student to eliminate background noise and assure quality.

4.4 Accessibility issues

As mentioned above, students with vision impairments have a wide range of visual capabilities. With regard to the physical accessibility of the classroom or working environments, there are a variety of strategies that teachers might employ that facilitate reasonable accommodation. Kochhar and West (1996) have suggested the following:

- Creation of barrier-free settings to enhance classroom access. These settings include: libraries, resource areas and technology or learning laboratories.
- Modifications in the physical grouping of desks
- Modification of seating arrangements to permit improved viewing
- Rearrangement or enlargement of vision tools or resources
- Use of audiotape equipment or alternative communication devices
- Rearrangement of classes, with consideration of their relationship to school entrances and exits (p. 73).

With regard to instructional strategies, accommodation for the students can be as simple as enlarging text on a copy machine and as complicated as producing entire books in braille. The following are some suggestions that teachers can follow in accommodating their students:

- Students with vision impairments, as mentioned in the preceding section, are very sensitive to extraneous noise. It is important that teachers be flexible about the classroom location or about the use of various pieces of equipment, for example, overhead fans, if there is excessive background noise.
- When putting notes on the board, teachers should repeat aloud what they are writing. Many students with vision impairments take their own notes and will not have access to anything that is written and not spoken.
- It is important to allow partially sighted students to sit near the front of the room or at other optimum locations.
- Teachers should be sensitive to possible environmental hazards to students with sight problems, be aware of emergency routes and provide assistance to students when necessary.

Environmental considerations with regard to use of assistive technology have received thorough treatment by Koenig and Holbrooke (2000). The following issues; available workspace, positioning, availability of electricity and portability of equipment are all important considerations for the teacher (p. 138).

5. CONCLUSION

There is in schools, an increasing gap between the technological "haves" and have nots" (Stainback & Stainback, 1992). Students who are blind or vision impaired require the same access as their sighted peers to a full range of technologies that are available for instruction. These technologies include: computers, libraries, information centres, technological laboratories and similar resources. In addition they require assistive technology devices specially tailored to their individual needs. Whether or not a school has a lot of technological resources, access by students with disabilities to available technology, as Kochhar and West (1996) have pointed out, is generally more limited than it is for their non-disabled peers. The same holds true for computer access in the home. Issues of access and equity are unavoidable when the high cost of computer equipment adaptation for students with vision impairment is considered. This is particularly the case since so much of the current assistive technology requires customising to the needs of the recipient.

Ready access to these devices and to the financial support to purchase them are lacking for many students with vision impairments, at least in our public schools. For these students, it is essential that teachers give special attention to computer station adaptations, and instruction, as well as training as early as possible in a student's schooling. This form of "early intervention for technology access " can promote independence long before a student with special technological needs reaches adolescence and begins the complex transition through high school to the worlds of employment or tertiary education. Throughout these years, the teacher, with the family and the school, holds the key to student success. Towards facilitating this goal, the paper has focussed upon a variety of fundamental concepts that considerably enhance teacher and learner effectiveness in using technology.

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